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6 JUNE 1952

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oceanographic cruise to the bering and chukchi seas, summer 1949

PART III: PHYSICAL OBSERVATIONS AND SOUND VELOCITY IN THE DEEP BERING SEA

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U. S. NAVY ELECTRONICS LABORATORY, SAN DIEGO, CALIFORNIA

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statement of problem

BuShips problem NE 120221, subtask 3 (NEL 2A5): "Investigate problems in oceanography through suitably devised methods, means, and equipments." This report presents the results of physical oceanographic observations made in the southeastern Bering Sea during the summer of 1949.

conclusions

1. A sharp temperature minimum exists at depths between 100 and 150 meters. It is the result of local winter cooling and convection reinforced by a sluggish arcuate southeasterly flow of cold winter water across the Bering Sea from the Siberian coastal areas. A temperature minimum of this type probably exists throughout the deep Bering Sea in summer.

2. The computed surface circulation is counterclockwise in the area surveyed with maximum speeds of about 0.3 knot.

3. Doubt is cast upon the generally accepted conclusion of a northeasterly surface current from between the Komandorski and Near Islands across the central Bering Sea to St. Matthew Island.

4. A well-developed deep sound channel exists in the deep Bering Sea during summer. The axis, which occurs around 150 meters in depth, is much shallower than generally found in open oceans.

recommendations

1. Undertake a program of observation for the central and northwest Bering Sea to determine positively the structure and circulation in those regions.

2. Utilize the Bering Sea as a location for research investigations involving the horizontal refraction of low-frequency signals and their propagation over ridges and from deep into shallow water.

work summary

1. A total of 27 water bottle casts, 86 bathythermograms, and 61 surface water samples were taken in the southeastern Bering Sea during the summer of 1949 from HMCS CEDARWOOD. Temperature, salinity, and dissolved-oxygen content were obtained at intervals to 1100 meters, in general, with each bottle cast. These data were reduced and analyzed.

The observational program in the deep Bering Sea was under the scientific direction of Dr. W. M. Cameron, Pacific Oceanographic Group, Canada, now Director of the Institute of Oceanography, University of British Columbia. Personnel participating in the observational program were W. M. Cameron, A. J. Dodimead, R. H. Herlinveaux, and J. P. Tully (stations 23-30), P. O. G., Canada; E. C. LaFond (stations 23-30), R. M. Lesser, J. C. Roque, and J. F. T. Saur, Jr., USNEL.

It was decided that the data should be reduced at NEL, so the responsibility for the analyses and conclusions lies primarily upon the senior author.

The cooperation of the officers and men of HMCS CEDARWOOD is gratefully acknowledged.

This report covers work to January 1952.

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PREFACE

During the months of July and August, 1949, the U. S. Navy Electronics Laboratory and the Canadian Pacific Oceanographic Group collaborated in a varied program of acoustical and oceanographic research, mainly in the Bering and Chukchi Seas. This joint venture was made possible through the cooperation of agencies of the Canadian and United States Navies who furnished the vessels and necessary funds for the cruise.

Oceanographic measurements aboard the United States vessels were taken primarily for the evaluation of experimental sound-transmission and sound-propagation data. The collection of sound data took priority, and oceanographic data could be collected only when no interference with sound experiments was assured. The time of the Canadian vessel was devoted exclusively to oceanography, and the data collected by this ship are intended to supplement our present knowledge of the physical and chemical characteristics of arctic waters.

The expedition was made by three ships which formed a small task group under the military command of Commander John D. Mason, USN. Dr. Waldo K. Lyon of the Navy Electronics Laboratory directed the entire acoustic and oceanographic program, with Dr. J. P. Tully of the Pacific Oceanographic Group as senior scientist in charge of the Canadian group.

Participating ships were:

USS BAYA (AG(SS) 318), under the command of CDR John D. Mason, USN;
HMCS CEDARWOOD, under the command of LCDR J. E. Wolfenden, RCN(R);
USS EPCE(R) 857, under the command of LCDR D. J. McMillan, USN.

The oceanographic program was divided into three major parts:

1. *Physical oceanographic studies.* These were carried on primarily aboard HMCS CEDARWOOD and from a shore station at Cape Prince of Wales. Some supplemental data were collected aboard USS EPCE(R) 857 and USS BAYA.

2. *Oceanographic measurements as adjuncts to, and in support of, sonar work.* These measurements were taken from USS BAYA and USS EPCE(R) 857.

3. *Sea floor and biological studies.* This work was primarily conducted aboard USS EPCE(R) 857, with some additional work on HMCS CEDARWOOD.

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INTRODUCTION

This is the third* of a series of reports covering oceanographic researches made on a joint U. S.-Canadian expedition to subarctic and arctic water during the summer months of July and August 1949. The observations reported here were made from HMCS CEDARWOOD by scientific personnel from Pacific Oceanographic Group, Canada, and U. S. Navy Electronics Laboratory. The program in the deep Bering Sea represents an early phase of the over-all oceanographic investigations and is herein discussed independently of the observations made in the shallow Bering and Chukchi Seas.

The Bering Sea is the largest adjacent sea of the Pacific Ocean, and approximately half of it is a deep basin with depths of around 2100 fathoms. Nevertheless our knowledge of the oceanographic structure and circulation of deep portions of the Bering Sea has been very limited because previous information was derived from surface observations, bathythermograms, and relatively few oceanographic stations located within 80 nautical miles of the Aleutian chain.

HMCS CEDARWOOD undertook, in the two and one-half weeks available, a program of oceanographic observations in the southeastern one-third of the deep Bering Sea. The sound-velocity structure obtained from these observations has been utilized in the evaluation of concurrent acoustical tests. The structure will also be of value for planning future tests and military operations, since great-circle supply routes from Unimak Pass to island bases in the Aleutians would be defended in the area surveyed.

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* The two previous reports of the series were: NEL Report 204, *Oceanographic Cruise to the Bering and Chukchi Seas, Summer 1949. Part I: Sea Floor Studies*, by E. C. Buffington, A. J. Carsola, and R. S. Dietz, 2 October 1950 and NEL Report 211, *Oceanographic Cruise to the Bering and Chukchi Seas, Summer 1949. Part II: Currents*, by R. M. Lesser and G. L. Pickard, 24 October 1950.

PREVIOUS INFORMATION

Previous knowledge of the vertical temperature and salinity structure was based almost entirely upon pre-World War II observations. Some of the first observations to depths greater than 100 fathoms were 11 serial observations of temperature only, made by the U. S. Fish Commission steamer Albatross in the years 1893 and 1895.[1] These observations, which were made in conjunction with biological investigations, were located in the southeastern corner of the deep Bering Sea primarily east of 173° W. In the area between 175° W and 172° E and less than 80 miles into the Bering Sea from the Aleutian chain, USS GANNETT occupied twenty oceanographic stations — temperature and salinity — in 1933[2] and USS OGLALA occupied nineteen stations in 1935.[3] In 1934 USCGC CHELAN made two sections along the continental slope between Unalaska Island and the Pribilof Islands,[2] and in 1936 occupied several stations along and near the ridge between Attu Island and the Komandorski Islands.[4] Some Russian observations of 1932-1933[5] were also located along the Aleutian Islands and the fringe of the deep Bering Sea on the northwest, but we have been unable to obtain the basic data for examination.

After World War II, in 1948, USCGC NORTHWIND occupied four stations along the chain from Unimak Pass to Tanaga Island, but sampled only to depths of about 100 meters.[6]

During and since World War II, many bathythermograph observations were made in the southern part of the deep Bering Sea almost exclusively by U. S. Navy vessels. Those observations of temperature versus depth to 450 feet taken between May 1942 and August 1948 have been compiled and analyzed at Scripps Institution of Oceanography to show the mean monthly and seasonal sea-temperature distributions.[7] These data are very sparse north of 54° N. A series of bathythermograms taken from USS NEREUS proceeding from Adak Island to St. Paul Island during the summer of 1947[8] provided the only set from this region from which a synoptic analysis of temperature distribution had been made prior to this report.

In addition to the above physical observations, the U. S. Navy Hydrographic Office has compiled drift observations from ships. From these, a stream drift chart of the world for the month of July has been published, based upon observations received over a 30-year period.[9]

Early investigators generally concluded that the character of the water mass in the deep Bering Sea was the same as that of Pacific Subarctic Water. There was less agreement as to the current structure. The conclusions of Ratmanoff[5] and as modified by Goodman, *et al.*,[10] indicate a flow into the Bering

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[1] C. H. Townsend, *Dredging and Other Records of the U. S. Fish Commission Steamer ALBATROSS*, Commission of Fish and Fisheries, Commission Report no. 1900, 1901.

[2] C. A. Barnes and T. G. Thompson, *Physical and Chemical Investigations in Bering Sea and Portions of the North Pacific Ocean*, University of Washington, 1938.

[3] USS OGLALA, Scripps Institution of Oceanography, Manuscript Records, 1935.

[4] T. W. Vaughan, *et al.*, *International Aspects of Oceanography; Oceanographic Data and Provisions for Oceanographic Research*, National Academy of Sciences, 1937.

[5] G. E. Ratmanoff, *On the Hydrology of the Bering and Chukchi Seas, Explorations of the Seas of the Far East*, Hydrologic Institute, Leningrad, and Pacific Ocean Institute of Fishing Industry, Vladivostok, 1937.

[6] C. W. Thomas, *Physical and Zoological Investigations in Bering Sea and Portions of the Arctic Ocean* (CONFIDENTIAL), Coast Guard, 1948.

[7] J. G. Pattullo *et al.*, *Sea Temperature in the Aleutian Island Area*, Scripps Institution of Oceanography, Oceanographic Report no. 24, April 1950.

[8] E. C. LaFond *et al.*, *Oceanographic Measurements from the USS NEREUS on a Cruise to the Bering and Chukchi Seas, 1947; Interim Report* (RESTRICTED), NEL Report 91, 25 February 1949.

[9] Hydrographic Office, H. O. Publication no. 1400, *Stream Drift Chart of the World, July* (Back of H. O. 1400, Pilot Chart of the North Pacific), July 1951.

[10] J. R. Goodman *et al.*, *Physical and Chemical Investigations: Bering Sea, Bering Strait, Chukchi Sea, During the Summers of 1937 and 1938*, University of Washington, 1942.

Sea through the Aleutian passages, especially between the Komandorski Islands and the Near Islands, northeastward across the deep Bering Sea to St. Matthew Island; a counterclockwise eddy into the Oyashio Current serves to return part of the water to the Pacific while the remainder flows northward through the Bering Strait. On the other hand, the Hydrographic Office stream drift chart indicates that the flow into the Bering Sea takes place only through the narrow passages of the eastern Aleutian Islands and that a weak southerly drift out of the Bering Sea occurs from the Rat Islands to Kamchatka. The latter point of view has been given recent support by Scruton (personal communication) from geological investigations in the region of Attu Island.

OBSERVATIONS

Between 10 July and 26 July 1949, 27 oceanographic stations were occupied in the southeastern one-third of the deep Bering Sea and, in addition to the 27 bathythermograph observations taken at the oceanographic stations, 59 bathythermograms were taken and 61 surface water samples obtained at locations between the stations (see Appendix, fig. A1).

The bottle casts at the oceanographic stations were made in the traditional manner using reversing water bottles to obtain water samples and reversing thermometers to obtain temperatures at 12 estimated depths (10, 25, 50, 75, 100, 150, 250, 400, 600, 800, 1000, and 1100 meters). Surface observations were taken with a bucket and calibrated surface thermometer. A portion of each water sample was analyzed immediately aboard ship to determine the concentration of dissolved oxygen. The remainder of the water sample was drawn and sealed for later laboratory chlorinity titration, as were surface water samples obtained with each bathythermograph observation at the intermediate locations between oceanographic stations. Data were reduced following procedures given by LaFond.[11]

The data are reproduced in the Appendix. These include Table 1, Oceanographic Station Data: temperature, salinity, and dissolved oxygen at observed and interpolated depths, plus density (σ_t), computed sound velocity, and dynamic height anomaly (ΔD) at interpolated depths for each oceanographic station and Table 2, Sea-Surface and Meteorological Observations. Figures A2 through A6 give the distribution of temperature, salinity, and dissolved oxygen at 0, 50, 100, 250, and 500 meters. The bathythermograph data, which were used primarily in the analysis of acoustical tests, and also in the interpretation of temperature data in the near-surface layers of oceanographic casts, are not reproduced here but are on file at the U. S. Navy Hydrographic Office, Washington, D. C.

At a number of stations the oceanographic data do not extend to a depth of 1100 meters as intended. Because of severe weather conditions during the midpart of the survey (stations 7 through 22) and in spite of maneuvering the ship on station to reduce wire angle, much difficulty in making the casts and premature tripping of the water bottles were encountered due to the ship's roll. As a result, during the reduction and analysis, a considerable number of data had to be discarded as erroneous. Of the reported data, the temperature-salinity relations were found to be consistent, but in some cases the observed depths are of uncertain reliability because the functioning of unprotected thermometers seemed erratic. In these cases, the curve giving the best fit to the thermometric depths might result in a difference between the adopted depth and thermometric depth of 10 to 20 meters at greater depths, whereas a difference of less than 10 meters should be expected. These data have been included with appropriate notations.

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[11] E. C. LaFond, *Processing Oceanographic Data*, Hydrographic Office, 1951.

WATER MASS AND STRUCTURE

As was indicated by previous investigations, the water mass of the deep Bering Sea as defined by the temperature-salinity relation is of the same character as the Pacific Subarctic Water which occurs immediately south of the Aleutian Islands. An exception to this generality occurs especially between 100 and 200 meters, where there is a pronounced temperature minimum with a temperature usually less than 2.5° C. (See fig. 1 for the vertical distribution of temperature, salinity, and dissolved oxygen at station 19 which is typical of most of this area.) Around 200 meters both the temperature and salinity increase sharply and the temperature reaches a flat maximum of 3.6° C between 300 and 400 meters. Below 400 meters the water mass is practically identical with that of Pacific Subarctic Water. The dissolved-oxygen content is high from the surface to a depth around 150 meters and decreases rapidly below that depth. The content remains around 0.5 ml per liter from around 600 meters to the limit of the observations, which is typical of adjacent areas of the Pacific.

Only at station 23, which is but 20 nautical miles north of the Aleutian chain, did the temperature minimum fail to appear. A very weak temperature minimum about 3° C or none at all appears in the

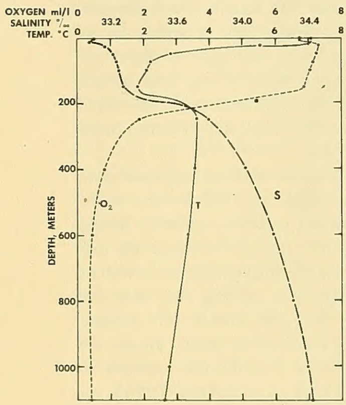


Figure 1. Vertical distribution of temperature, salinity, and dissolved oxygen, station 19.

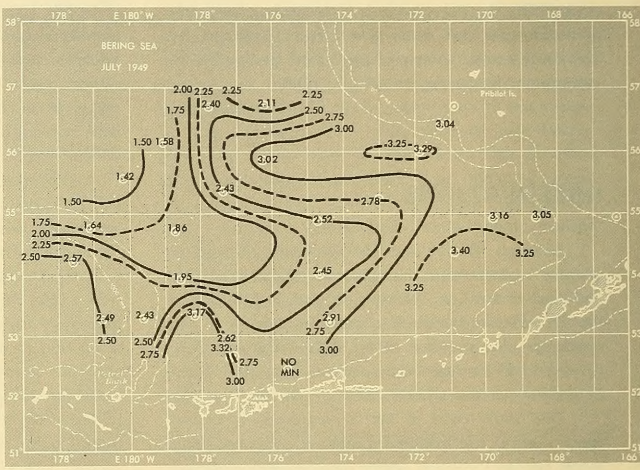


Figure 2a. Temperature minimum, ° C.

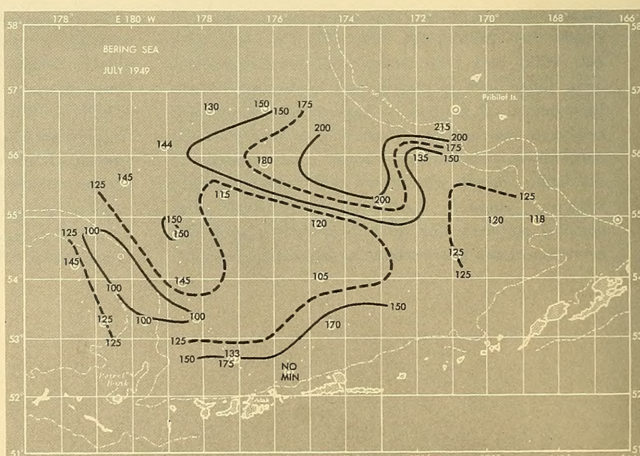


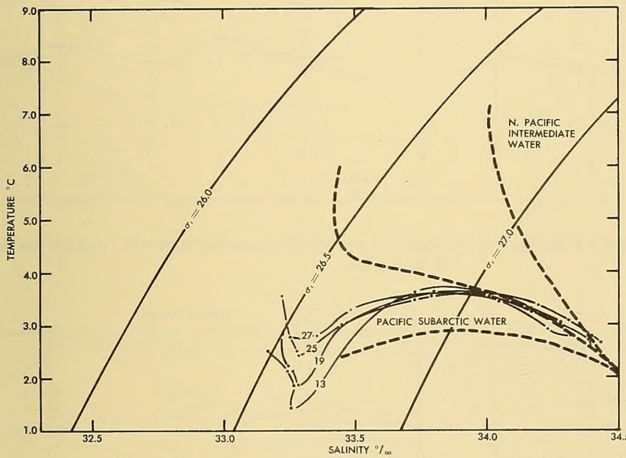
Figure 2b. Depth of temperature minimum, meters.

neighboring area south of the Aleutian Islands.[2,12] The region of the North Pacific having nearly the same vertical structure as the deep Bering Sea is just southeast of the Okhotsk Sea as shown by Carnegie station 119, 700 nautical miles to the southwest of Attu Island, which has a minimum of 1.6° C at 100 meters.[13] As will be discussed later, the Carnegie stations show that 600 nautical miles east-northeastward from station 119 toward Adak Island, the temperature at the minimum has increased to greater than 2.5° C and the minimum then disappears.

The horizontal character of the temperature minimum in the deep Bering Sea can be seen from the distribution of temperature and depth at the minimum surface (figs. 2a and 2b), temperature-salinity relationships at selected stations (fig. 3), and from selected vertical sections (figs. 4, 5, and 6). In general, the minimum exhibits a core or tongue-like distribution, with the temperature increasing from northwest to southeast. The depth of the main tongue

[12] USS BUSHNELL, *Observations in 1933*, Scripps Institution of Oceanography, Manuscript Records, no date.

[13] J. A. Fleming *et al.*, "Observations and Results in Physical Oceanography, Graphical and Tabular Summaries" (In: Carnegie Institution of Washington, Department of Terrestrial Magnetism, *Scientific Results of Cruise VII of the Carnegie during 1928-1929 under Command of Captain J. P. Ault*), Oceanography, 1945.



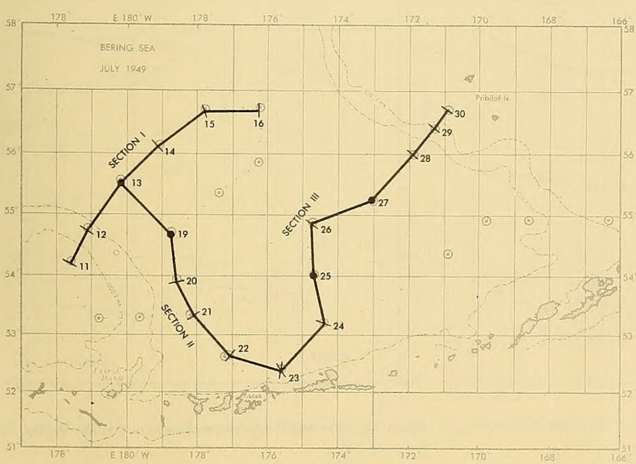


Figure 3a. Temperature-salinity relations at selected stations along axis of minimum temperature tongue.

Figure 3b. Locations of sections shown in figures 4, 5, and 6.

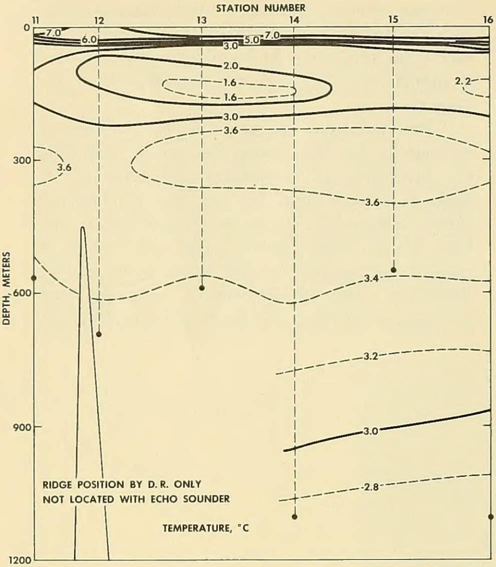


Figure 4a. Vertical distributions of temperature, section I (see figure 3b for locations).

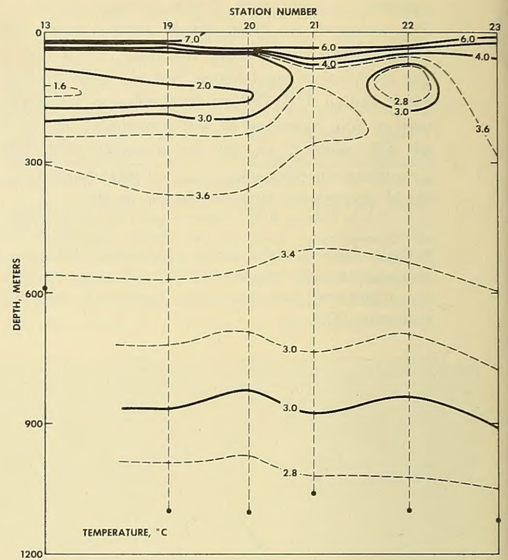


Figure 5a. Vertical distributions of temperature, section II (see figure 3b for locations).

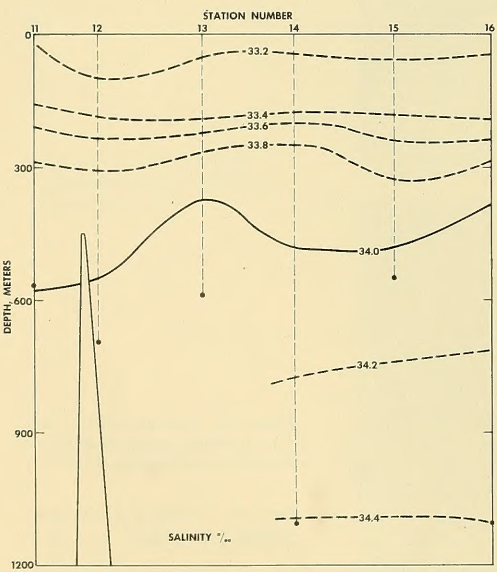


Figure 4b. Vertical distributions of salinity, section I (see figure 3b for locations).

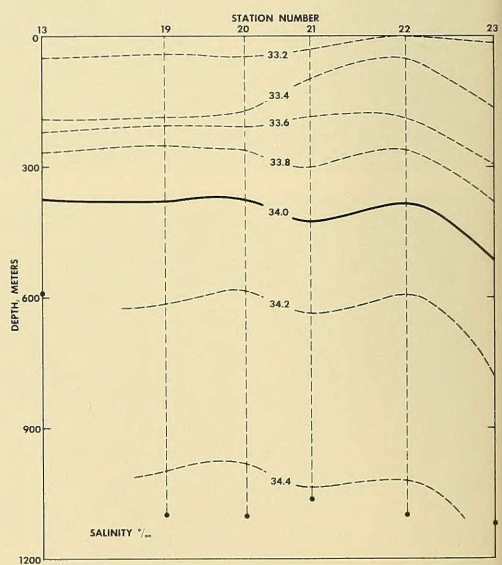


Figure 5b. Vertical distributions of salinity, section II (see figure 3b for locations).

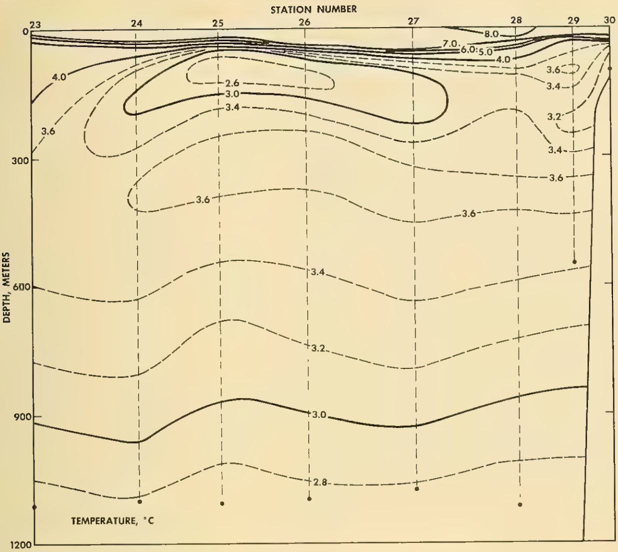


Figure 6a. Vertical distributions of temperature, section III (see figure 3b for locations).

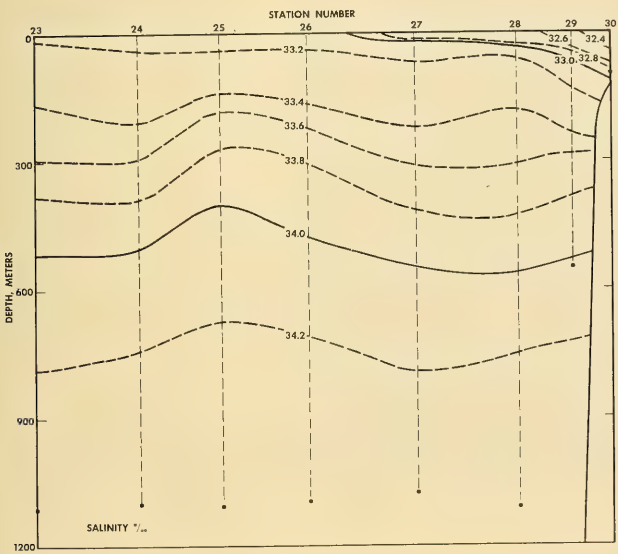


Figure 6b. Vertical distributions of salinity, section III (see figure 3b for locations).

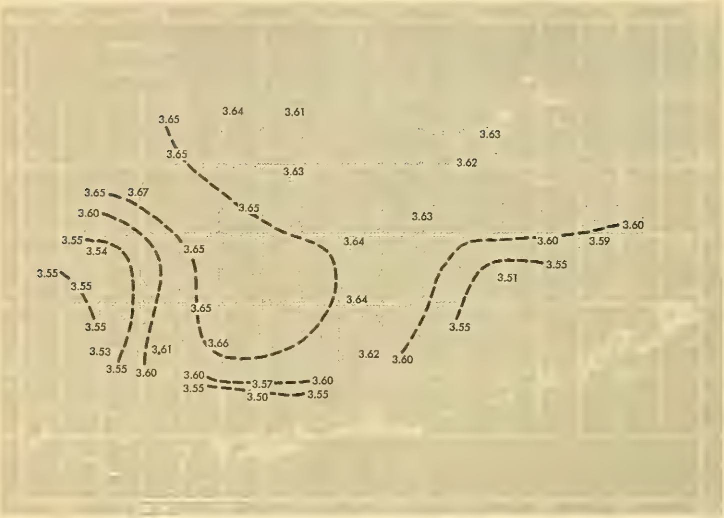


Figure 7a. Temperature maximum, ° C.

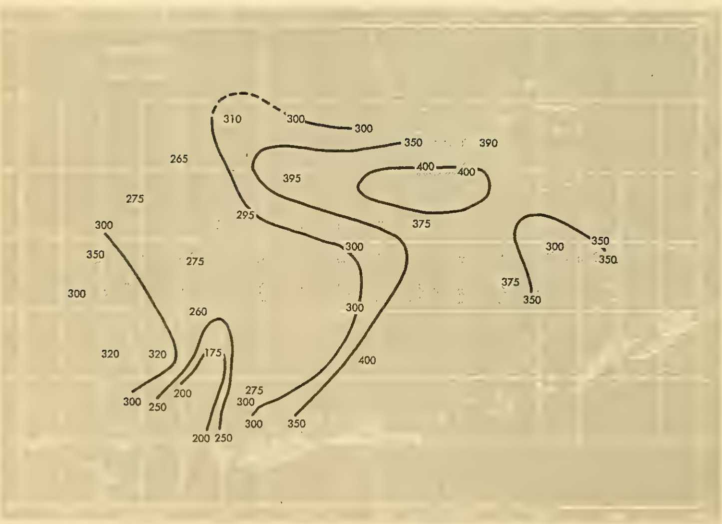


Figure 7b. Depth of temperature maximum, meters.

is nearly constant between 100 and 150 meters and the depth increases as the minimum degenerates.

The uniformity of temperature at the maximum is indicated in figure 7a. The depth of the maximum, figure 7b, is less significant than that of the minimum because the maximum is very flat, but a trend is observed similar to that of the depth of the temperature minimum. Below this maximum, both the horizonal and the vertical gradients of temperature and salinity are small.

Possible explanations of the temperature minimum are: (1) it is the result of winter cooling and convection currents to the depth of the minimum; (2) it is caused by deep water forced towards the surface in some manner; (3) it is the result of a flow from another region.

At first sight, it would appear that the temperature minimum represents the depth to which convection currents penetrated in winter, especially when it is also noted that the salinity becomes nearly constant at and above the temperature minimum and that the oxygen content is relatively high to this depth. However, the average minimum temperature of the mixed layer in this region during the winter is about 2.8° C.[7] It therefore seems improbable, even assuming below-normal winter temperatures, that the minimum temperatures of 2° C and less observed during the summer at depths less than 200 meters can be explained solely by winter cooling.

The possibility that the water is deep water forced toward the surface by topographic features or other cause is ruled out by its low salinity. There then remain to be examined possible sources from which a flow of cold low-salinity water could occur to reinforce the effect of local winter cooling.

The aforementioned degeneration of the temperature minimum from the Okhotsk Sea seems to rule out the possibility that any water moving into the Bering Sea between the Komandorski and Near Islands and east along the ridge would be responsible for the minimum. In fact, it was suggested by Sverdrup[14] that "this water (at the Carnegie Stations) of very low temperature probably comes from the Bering Sea, where it has entered the Pacific Ocean, and partly spread toward the east."

The origin of the cold water thus appears to be in the Bering Sea which has ample areas for the formation of such a water type in the Bristol Bay area, Olyutorski Gulf, and the Gulf of Anadyr-Norton Sound area. Barnes and Thompson[2] have eliminated the Bristol Bay area as a possible source, and this is confirmed in the present data by the configuration of the minimum. The Gulf of Anadyr-Norton Sound area, which is the most extensive of the above, is almost solidly covered with young sea ice during the winter.[15] Observations of February 1951[16] showed vertically uniform water of a temperature of −1.75° C and salinities around 32.5 $^0/_{00}$ to 33.0 $^0/_{00}$ in the region of the young sea ice north from St. Matthew Island and around St. Lawrence Island. Comparable conditions probably occur throughout the ice-covered regions along the Siberian coast which include Olyutorski Gulf. A source in these regions would be in agreement with the configuration of the feature indicating movement from the northwest (figs. 2a and 5) and with the T-S relations (fig. 3) which show that it would have a salinity of about 33.1 $^0/_{00}$ and temperature of less than 1.3° C. During the summer, water of less than 0° C has been observed to the southwest of St. Lawrence Island on several occasions but as a subsurface mass having less vertical extent. Although surface heating probably accounts partially for the decrease in thickness, some sinking and spreading of this winter water mass could easily occur because of the surface spreading of warmer low-salinity coastal waters which develops during the spring and summer. The present observations thus indicate that the minimum is created, at least partially, by the slow spreading of cold water at subsurface depth south and southeastward in a counterclockwise arc from the coast of Siberia or northern Bering Sea into the southeastern Bering Sea. A corollary to the above interpretation is that the minimum is a widespread feature existing throughout the major portion of the deep Bering Sea in summer.

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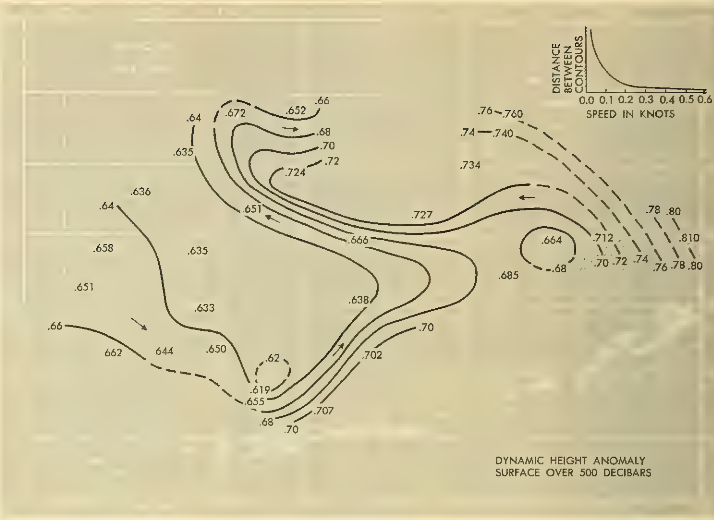
[14] J. A. Fleming *et al.*, *Observations and Results in Physical Oceanography* (vol. I-B of *Scientific Results of Cruise VII of the CARNEGIE during 1928-1929 under Command of Captain J. P. Ault; Oceanography)*, Carnegie Institution of Washington Publication no. 545, Department of Terrestrial Magnetism, 1945.

[15] Hydrographic Office, *Ice Atlas of the Northern Hemisphere*, H. O. Publication no. 550, 1946.

[16] USS BURTON ISLAND (AGB-1), *Bering Sea Expedition, Winter 1951* (CONFIDENTIAL), March 1951.

Figure 8a. Circulation of surface computed relative to the 500-meter surface. Dynamic height anomaly extrapolated into shallow water at stations 2 and 30.



CIRCULATION

The surface currents resulting from the distribution of mass — this excludes tidal currents and wind drift currents — are indicated by the dynamic topography of the surface over the 500-decibar surface (fig. 8a). Ideally, the reference surface should be at the depth of no motion, so that the computed currents would be the true currents caused by the distribution of mass. The 500-decibar surface has been used here because few data are available below that depth along the northwest line of stations. Where data are available to the 1000-decibar surface, at which the currents are negligible,[2] the pattern of surface current referred to this surface is not changed and the speeds are increased only about 15 per cent.

North of the Andreanoff Islands is an easterly flow of about 0.15 knot which backs to northeasterly and starts toward the Pribilof Islands. At the 55th parallel it meets and reinforces a strong westerly flow of 0.3 knot off the shelf forming an eddy configuration apparently returning toward the shelf. Unfortunately our observations do not extend far enough to indicate whether it again turns northwesterly or flows onto the shelf.

The surface salinity distribution (fig. A2b) agrees well with the currents from the dynamic topography. A pronounced tongue of low-salinity water (less than $33.00\,^{0}/_{00}$ extends into the Bering Sea with its axis along the strong westerly flow. The dynamic topography of the 150/500 decibar surface (fig. 8b) indicates at 150 meters a weaker but similar circulation — about 40 per cent of that at the surface — which would indicate that this westerly flow and associated low-salinity tongue is not a shallow transient feature but a semipermanent feature of the circulation. The weak southeasterly flow indicated in the western part of the region confirms the interpretation given earlier of the movement of water at the temperature minimum.

With reference to previous conclusions as to currents, the weak westerly component of 0.1 knot found by Barnes and Thompson[2] about 40 miles north of the Andreanoff Islands did not appear as a widespread feature in our observations, although station 22 seems to be associated with a small eddy. It can be concluded that this westerly component was probably associated with a small feature evi-

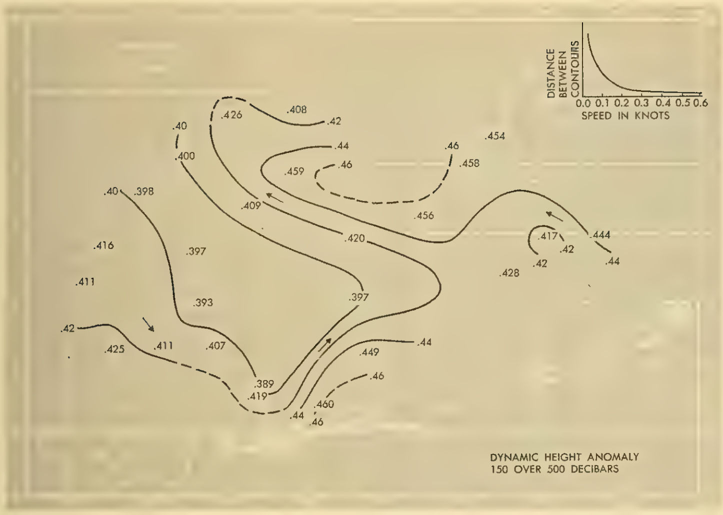


Figure 8b. Circulation of 150-meter level computed relative to the 500-meter surface. Dynamic height anomaly extrapolated into shallow water at stations 2 and 30.

dent from their closely spaced observations, but masked by the more general circulation obtained by our more widely spaced observations. The higher east and northeasterly speeds observed near the islands by Barnes and Thompson are in good agreement with our observations, as these would be required by continuity to supply the water for the northeasterly flow.

Our observations do not extend far enough to the northwest to verify or contradict the northeasterly flow from west of the Near Islands to St. Matthew Island. If the earlier proposed circulation of the water creating the temperature minimum is assumed to be correct, some doubt is cast upon the validity of any appreciable northeasterly surface current in the central deep Bering Sea because a large velocity shear would have to be present between 150 meters and the surface. It seems more likely that the greatest shear would exist at the interface between surface layers and the subarctic Pacific water which is at 200 to 300 meters. It would appear that there is no appreciable surface current in the central deep Bering Sea, but that an extremely slow drift of water to the northeast might occur at levels between 300 and 1000 meters. Thus the surface inflow of Pacific water through the passes of the eastern Aleutian Islands, plus the deep inflow between the Komandorski and Near Islands, and the river inflow would have to balance the outflow of the northerly current through Bering Strait and the Oyashio current. A future extension of observations northwestward to the International Boundary, or to the Siberian continental shelf, if possible, seems necessary to resolve this question.

SOUND VELOCITY

surface layers

Of all oceanographic factors, probably the most important, role is played in military operations by the sound-velocity structure in the surface layer. Generally speaking, the sound-velocity structure in the surface layer is subject to diurnal effects and short-period variations of less than a month because of the influence of atmospheric conditions. In the Bering Sea in summer, the diurnal effects are nearly negligible because of the persistent stratus overcast.

The character of the sound-velocity structure can be seen by examining the vertical velocity distributions computed from the data obtained by bottle

casts at selected stations (fig. 9). In a few cases, negative temperature and sound-velocity gradients started at the surface, as at station 23. These were generally along the Aleutian chain and in the southeastern section. Farther away from the chain, a mixed layer of the order of 20 to 25 meters in depth occurred at every station, the layer becoming slightly less deep near the edge of the continental shelf. Depending upon the slight variation of gradients in temperature and salinity, this mixed layer at times might be an isovelocity layer, as at station 20. At other times, when well mixed, it would have a weak positive sound-velocity gradient, as at station 26. In these latter two cases, long sonar ranges on surface ships and submarines above layer depth are predicted from the sound-velocity structure. However, on this cruise this surface layer and the accompanying long predicted ranges were coincident with fairly high sea state of about 4 and 5, which in turn reduces the effective ranges. Because of the stratus overcast these mixed layers would persist much longer than average after the wind decreased. Thus, it can be concluded that ranges would be limited by sea state and that usually, in the absence of high sea state, surface sound ranges in the deep Bering Sea would be above average compared with summer ranges in other parts of the north Pacific Ocean.

deep sound channel

The most striking feature of the sound-velocity distribution is the deep sound or Sofar channel. This channel is directly related to the temperature minimum but does not necessarily coincide with it, because of the effect of pressure and salinity on sound velocity.

The axis of the sound channel — the depth of minimum velocity — is at a depth of 75 to 200 meters and the velocity at the axis increases from northwest to southeast (fig. 10). This is a very shallow depth compared with that occurring most generally in the open oceans; for example, the sound-channel axis over the major portion of the northeast Pacific Sofar

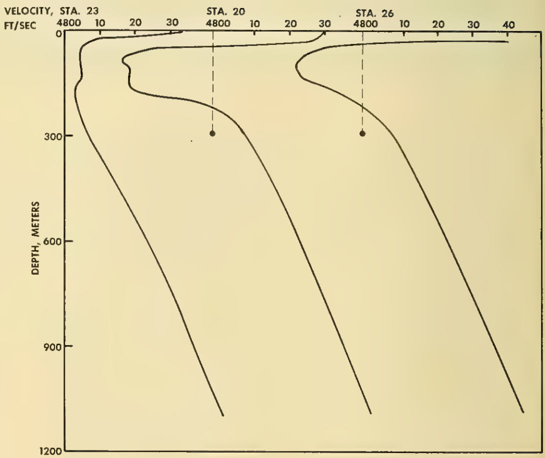


Figure 9. Sound-velocity structure, computed from data obtained by bottle cast, at selected stations (see figure 3b for locations).

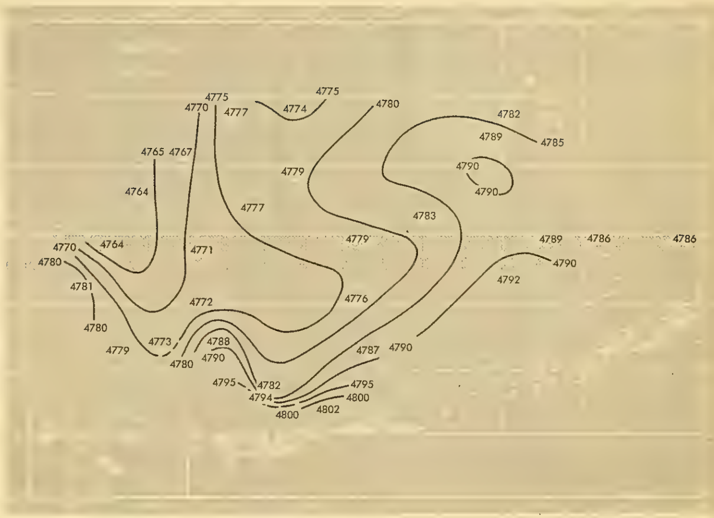


Figure 10a. Sound velocity at the channel axis, feet per second.

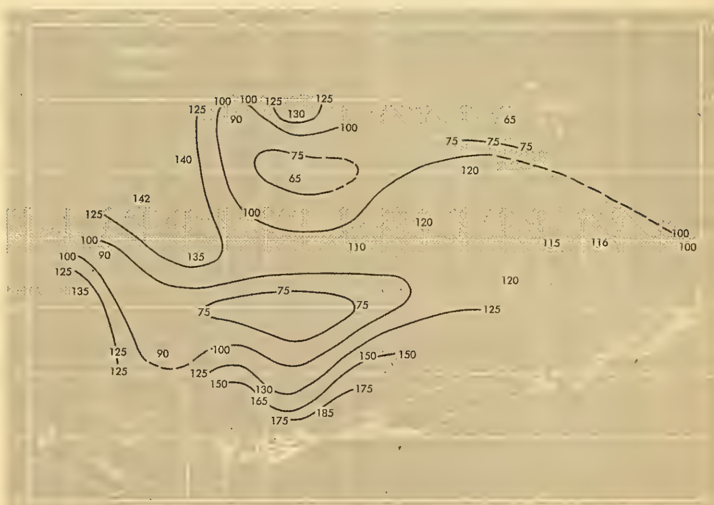


Figure 10b. Depth of sound-channel axis, meters.

network area is at a depth below 400 meters.[17] In the Gulf of Alaska during winter the sound-channel axis is at a depth of around 100 meters, but the channel is weak. On the contrary, though comparatively shallow, the channel of the deep Bering Sea is strong. The angle of the limiting ray (defined as the angle of departure at the axis of the ray which becomes horizontal at the top of the channel — see reference 17 for detailed definitions) is between 8° and 10°, which is comparable to the region between 35° and 45° N in the northeast Pacific. The width of the channel (vertical distance between top and bottom) is generally less than 900 meters.

A similar sound channel occurring at shallow depths has been reported in Canadian Atlantic waters of the Bay of Fundy, Gulf of St. Lawrence and the Scotian Shelf during the summer and autumn months.[18] The depth of the axis in those waters is 50 to 75 meters, but the channel is generally bottom-limited because of the shallow depths occurring in that region. The Bering Sea, however, is much deeper than most of the aforementioned Atlantic region and the channel caused by refraction of sound is not bottom-limited. The bottom of the channel is as shallow as 600 meters at a few stations and, by extrapolation, not deeper than 1200 meters at the remainder, Recent unpublished observations in the Gulf of Alaska taken on the Northern Holiday cruise[19] indicate a strong channel in that region with the axis around 75 meters, and one also occurs in the far northwest Pacific off the Okhotsk Sea and the Kamchatkan Peninsula. Because of their shallow depth, such sound channels are favorable for ship-to-ship transmissions at long ranges.[20] Since a submarine can dive to depths well within the upper part of the sound channel, transmission between submarines might be accomplished at even greater ranges.

The sound conditions in the deep Bering Sea would be particularly adaptable to a Sofar network. Cables to hydrophones would be short because the channel is shallow, the bottom slopes at the Aleutian Islands are steep, and protected bays are available for cable-landing sites. Stations could be located along the Aleutian Chain, and it is possible that a station could be located at the Pribilof Islands which are relatively near the edge of the continental shelf. The axis of the sound channel appears to rise across the edge of the shelf although it approaches very near the bottom, so that it is possible that reception would be satisfactory at such a location. More detailed oceanographic observations and actual acoustic tests would be required in order to verify this.

Because of the lack of traffic in the region, operational use of such a Sofar network would not be practical except in case of war. However, the region might profitably be used in peacetime for research and experimentation on the propagation of Sofar signals. The horizontal gradient in sound velocity at the axis, of the order of 15 feet per second per 100 nautical miles, offers an opportunity to study horizontal refraction effects. Much interest lies also in the effect of seamounts and ridges upon the propagation of the signal. Northwest of Adak there is a continuous ridge of some 200 miles long of varying minimum depth around 400 meters over which such tests as desired could be made. The fairly regular continental slope and flat Bering Sea shelf provide an excellent location for examining the change of the sound channel and sound propagation entering from deep into shallow water. For such investigations the Bering Sea — though remote — should be considered as a test area because of the favorable sound conditions and because Navy bases from which ships could operate do exist in the region.

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[17] E. R. Anderson, *Preliminary Study of the Deep Sound Channel in the Area Covered by the Eastern North Pacific SOFAR Network*, Naval Research Laboratory, U. S. Navy Journal of Underwater Acoustics, vol. 1, no. 1 (RESTRICTED), January 1951, pp. 75-86.

[18] W. B. Bailey *et al.*, *Sound Channels in Canadian Atlantic Waters* (RESTRICTED), Canada, Atlantic Oceanographic Group, 13 November 1950.

[19] W. S. Wooster, *Operation NORTHERN HOLIDAY, August-September 1951; A Preliminary Report*, Scripps Institution of Oceanography, Reference no. 51-46, 15 November 1951.

[20] K. V. Mackenzie, *Long-Range Sound Transmission in the Deep Bering Sea* (CONFIDENTIAL), NEL Report 280 (in press).

* Computed according to reference 11.

SUMMARY OF CONCLUSIONS

1. In the southeastern Bering Sea, a sharp temperature minimum exists at depths between 100 and 150 meters. This minimum is the result of local winter cooling and convection reinforced by a sluggish arcuate southeasterly flow of cold winter water across the Bering Sea from the Siberian coastal areas. It probably exists throughout the deep Bering Sea in summer.

2. The water below 400 meters is a horizontally uniform Pacific Subarctic water mass.

3. The surface circulation is generally counterclockwise in the area surveyed, with maximum surface currents of about 0.3 knot.

4. Some doubt arises as to whether the generally accepted theory of northeasterly surface current from between the Komandorski and Near Islands across the Bering Sea towards St. Matthew Islands is correct. Future observations in the central and northwest deep Bering Sea are desirable in order to resolve this problem.

5. Surface sonar ranges in the deep Bering Sea during summer would be long except where limited by high sea state.

6. A well-developed deep sound channel exists in the deep Bering Sea during summer, its axis being at depths of about 150 meters. It is unusual because the axis occurs at this shallow depth, the channel is not bottom-limited, and an appreciable horizontal gradient of sound velocity occurs along the axis.

7. The deep sound channel in the Bering Sea would be favorable for research investigations concerning horizontal refraction of Sofar signals and their propagation over ridges and from deep into shallow water.

RECOMMENDATIONS

1. Undertake a program of observation for the central and northwest Bering Sea to determine positively the structure and circulation in those regions.

2. Utilize the Bering Sea as a location for research investigations involving the horizontal refraction of low-frequency signals and their propagation over ridges and from deep into shallow water.

appendix: detailed oceanographic data

TABLE 1. DATA FOR OCEANOGRAPHIC STATIONS. Values in Parentheses Are Observed Values of Doubtful Reliability. It Should Further Be Noted That in a Few Cases the Data Have Been Extrapolated to the Next Standard Depth Below the Deepest Observed Value. Dates and Time are GCT.

Station	Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
STATION 1; Lat. 54° 24′ N; Long. 164° 13′ W; Date 10 July; Messenger Time — Shallow Cast 0355; Wire Angle — Shallow Cast 15°; Depth to Top of Thermocline 8 Meters	0	8.39	31.36	7.06	0	8.39	31.36	7.06	24.39	4842.5	0
	10	7.97	31.37	7.40	10	7.97	31.37	7.40	24.45	4838.0	.0352
	25	5.91	31.80	7.32	20	5.71	31.76	7.37	25.05	4810.8	.0672
	40	4.10	31.91	6.84	30	5.60	31.85	7.25	25.14	4810.4	.0960
	60	3.67	31.92	6.81	40	4.10	31.91	6.84	25.34	4790.8	.1234
	90	3.72	32.08	6.57	50	3.79	31.92	6.80	25.38	4787.2	.1496
					75	3.82	31.98	6.72	25.43	4789.3	.2141
					90	3.72	32.08	6.57	25.52	4789.2	.2519
STATION 2; Lat. 54° 58′ N; Long. 166° 20′ W; Date 10 July; Messenger Time — Shallow Cast 1408; Wire Angle — Shallow Cast 0°; Depth to Top of Thermocline 8 Meters	0	9.44	31.96	7.80	0	9.44	31.96	7.80	24.69	4858.0	0
	10	6.93	31.86	9.63	10	6.93	31.86	9.63	24.98	4826.6	.0312
	25	4.78	32.25	7.11	20	5.00	32.11	8.10	25.41	4802.7	.0590
	50	4.53	32.57	6.84	30	4.73	32.32	7.04	25.61	4800.6	.0839
	75	3.75	32.74	6.25	40	4.63	32.45	6.95	25.72	4800.3	.1073
	100	3.21	32.88	5.23	50	4.53	32.57	6.84	25.82	4800.2	.1297
	125	3.22	32.94	5.21	75	3.75	32.74	6.25	26.04	4791.6	.1818
					100	3.21	32.88	5.23	26.20	4786.0	.2295
					125	3.22	32.94	5.21	26.25	4788.0	.2748
STATION 4; Lat. 54° 56′ N; Long. 168° 38′ W; Date 11 July; Messenger Time — Shallow Cast 0155, Deep Cast 0234; Wire Angle — Shallow Cast 0°, Deep Cast 0°; Depth of Top Bottle (Deep Cast) 244 Meters; Depth to Top of Thermocline 17 Meters	0	8.33	32.56	7.38	0	8.33	32.56	7.38	25.34	4846.9	0
	10	8.15	32.59	7.50	10	8.15	32.59	7.50	25.39	4845.5	.0263
	25	5.49	32.81	6.87	20	6.45	32.70	7.16	25.71	4824.7	.0508
	48	4.19	33.06	5.89	30	5.06	32.88	6.52	26.01	4807.4	.0723
	73	3.86	33.17	6.05	40	4.63	33.00	6.05	26.16	4802.7	.0917
	98	3.61	33.28	5.94	50	4.11	33.07	5.89	26.27	4796.5	.1099
	146	3.22	33.34	5.34	75	3.83	33.19	6.04	26.39	4794.6	.1527
	244	3.53	33.58	3.72	100	3.54	33.28	5.92	26.49	4792.4	.1929
	390	3.57	33.80	2.42	150	3.26	33.35	5.29	26.57	4791.9	.2690
	591	3.43	34.11	1.02	200	3.46	33.45	4.50	26.63	4798.0	.3419
	789	3.14	34.25	0.39	250	3.56	33.59	3.64	26.73	4803.0	.4111
	1000	2.85	34.34	0.49	300	3.58	33.66	3.11	26.79	4806.4	.4769
	1111	2.65	34.385		400	3.57	33.82	2.39	26.92	4813.1	.6004
					500	3.49	33.97	1.75	27.03	4818.6	.7125
					600	3.40	34.12	0.99	27.17	4824.0	.8133
					700	3.24	34.20	0.57	27.25	4827.9	.9049
					800	3.10	34.25	0.39	27.30	4832.0	.9908
					1000	2.85	34.34	0.49	27.40	4841.0	1.1500
					1100	2.65	34.38		27.44	4844.3	1.2234

* Computed according to reference 11.

 [redacted]

[redacted]

TABLE 1 (*continued*).

Station	Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
STATION 5; Lat. 54° 54′ N; Long. 169° 47′ W; Date 11 July; Messenger Time — Shallow Cast 0858, Deep Cast 0808; Wire Angle — Shallow Cast 5°, Deep Cast 10°; Depth of Top Bottle (Deep Cast) 147 Meters; Depth to Top of Thermocline 20 Meters	0	8.28	33.04	6.74	0	8.28	33.04	6.74	25.72	4848.4	0
	10	8.02	33.04	6.79	10	8.02	33.04	6.79	25.75	4845.8	.0227
	26	4.96	33.15	6.99	20	6.00	33.09	6.94	26.07	4820.4	.0437
	50	4.06	33.26	6.47	30	4.70	33.17	6.95	26.28	4804.1	.0622
	75	3.59	33.32	5.64	40	4.30	33.22	6.70	26.36	4799.1	.0793
	99	3.36	33.33	5.54	50	4.06	33.26	6.47	26.42	4796.6	.0958
	147	3.28	33.42	5.05	75	3.59	33.32	5.64	26.51	4791.8	.1352
	244	3.58	33.67	3.30	100	3.35	33.33	5.54	26.54	4790.0	.1732
	388	3.55	33.91	1.78	150	3.29	33.43	4.98	26.63	4792.6	.2465
	586	3.27	34.11	0.91	200	3.47	33.56	3.85	26.71	4798.6	.3159
	781	3.04	34.27	0.55	250	3.54	33.68	3.22	26.81	4802.6	.3814
	1001	2.74	34.40	0.57	300	3.60	33.78	2.68	26.88	4807.3	.4432
	1099	2.66	34.41		400	3.54	33.92	1.69	27.00	4812.7	.5584
					500	3.41	34.03	1.18	27.09	4817.8	.6639
					600	3.26	34.12	0.88	27.18	4822.0	.7613
					700	3.14	34.21	0.71	27.26	4826.5	.8513
					800	3.01	34.29	0.55	27.34	4831.1	.9343
					1000	2.75	34.40	0.57	27.45	4839.8	1.0841
					1100	2.66	34.41		27.46	4844.5	1.1537
STATION 6; Lat. 54° 23′ N; Long 170° 55′ W; Date 11 July; Messenger Time — Shallow Cast 1602, Deep Cast 1509; Wire Angle — Shallow Cast 5°, Deep Cast 0°; Depth of Top Bottle (Deep Cast) 146 Meters; Depth to Top of Thermocline 11 Meters	0	7.72	33.05	6.83	0	7.72	33.05	6.83	25.81	4841.3	0
	13	7.51	33.03	6.94	10	7.71	33.03	6.93	25.79	4841.8	.0221
	37	4.70	33.15	6.68	20	7.00	33.06	6.89	25.91	4833.3	.0437
	61	4.23	33.19	6.23	30	4.91	33.12	6.76	26.22	4806.4	.0633
	87	3.73	33.26	5.75	40	4.65	33.16	6.65	26.28	4803.7	.0811
	123	3.39	33.33	5.42	50	4.46	33.18	6.48	26.31	4801.7	.0985
	146	3.59	33.42	4.60	75	3.92	33.20	5.98	26.39	4795.9	.1407
	243	3.44	33.62	3.86	100	3.58	33.24	5.62	26.45	4792.8	.1813
	393	3.51	33.86	2.31	150	3.60	33.43	4.54	26.60	4796.9	.2575
	588	3.36	34.05	1.30	200	3.51	33.55	4.13	26.70	4799.1	.3279
	783	3.13	34.25	0.47	250	3.45	33.63	3.77	26.77	4801.6	.3944
	987	2.82	34.32	0.55	300	3.49	33.73	3.21	26.85	4805.6	.4576
	1096	2.71	34.32	0.73	400	3.50	33.87	2.24	26.95	4812.3	.5758
					500	3.43	33.97	1.67	27.04	4817.8	.6854
					600	3.34	34.06	1.25	27.12	4822.8	.7878
					700	3.24	34.13	0.81	27.19	4827.6	.8840
					800	3.12	34.19	0.44	27.25	4832.3	.9748
					1000	2.81	34.32	0.57	27.38	4840.4	1.1398
					1100	2.70	34.32	0.75	27.39	4844.8	1.2162

* Computed according to reference 11.

STATION 7; Lat. 52° 37′ N; Long. 177° 14′ W; Date 16 July; Messenger Time — Shallow Cast 0257, Deep Cast 0208; Wire Angle — Shallow Cast 5°, Deep Cast 5°; Depth of Top Bottle (Deep Cast) 146 Meters; Depth to Top of Thermocline 26 Meters

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	7.33	33.18	7.05	0	7.33	33.18	7.05	25.96	4836.8	0
10	7.22	33.15	6.74	10	7.22	33.15	6.74	25.95	4836.0	.0206
24	6.59	33.19	6.63	20	7.06	33.17	6.66	25.99	4828.5	.0410
48	3.93	33.35	5.24	30	4.90	33.25	6.50	26.32	4806.8	.0597
74	3.87	33.44	5.12	40	4.01	33.31	5.51	26.46	4795.6	.0762
98	3.72	33.46	4.94	50	3.93	33.36	5.22	26.51	4795.2	.0918
146	3.44	33.48	4.89	75	3.87	33.44	5.12	26.58	4796.4	.1293
245	3.46	33.62	3.57	100	3.70	33.46	4.94	26.61	4795.4	.1657
390	3.44	33.88	1.74	150	3.40	33.48	4.87	26.66	4794.4	.2367
495	3.32	34.09	0.90	200	3.37	33.55	4.21	26.72	4797.2	.3054
781	3.19	34.23	0.42	250	3.46	33.62	3.52	26.76	4801.7	.3718
971	2.88	34.33	0.56	300	3.50	33.69	2.87	26.82	4805.5	.4360
1083	2.78	34.335		400	3.43	33.92	1.64	27.01	4811.6	.5534
				500	3.31	34.10	0.87	27.15	4816.7	.6552
				600	3.26	34.15	0.54	27.21	4822.1	.7484
				700	3.23	34.19	0.45	27.24	4827.8	.8385
				800	3.17	34.24	0.42	27.28	4833.2	.9255
				1000	2.83	34.33	0.64	27.39	4940.6	1.0867
				1100	2.77	34.34		27.40	4845.9	1.1625

STATION 9; Lat. 53° 17′ N; Long. 179° 38′ W; Date 16 July; Messenger Time — Shallow Cast 1923, Deep Cast 1948; Wire Angle — Shallow Cast 5°, Deep Cast 5°; Depth of Top Bottle (Deep Cast, 144 Meters; Depth to Top of Thermocline 21 Meters; Depths Questionable Below 400 Meters

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	6.32	33.15	6.26	0	6.32	33.15	6.26	26.07	4823.7	0
11	6.25	33.17	6.83	10	6.26	33.17	6.83	26.10	4823.6	.0194
25	5.46	n. s.		20	6.15	33.19	6.73	26.13	4822.8	.0385
49	3.29	33.30	6.56	30	4.60	33.22	6.64	26.33	4802.6	.0565
82	2.26	33.31	6.89	40	4.14	33.27	6.57	26.42	4797.1	.0731
106	2.23	33.30	6.62	50	3.28	33.30	6.57	26.52	4785.8	.0888
144	2.43	33.33	6.26	75	2.35	33.31	6.58	26.62	4774.1	.1257
240	3.53	33.69		100	2.22	33.30	6.69	26.62	4773.7	.1615
386	3.56	33.91		150	2.47	33.34	6.21	26.63	4780.5	.2329
574	3.32	34.18		200	3.13	33.57		26.75	4793.7	.3013
(666)	3.28	(34.01)		250	3.56	33.71		26.83	4803.5	.3653
				300	3.60	33.80		26.89	4807.4	.4263
				400	3.54	33.93		27.00	4813.1	.5403
				500	3.40	34.06		27.12	4817.8	.6443
				600	3.30	34.22		27.26	4822.9	.7370
				650	3.28	34.30		27.32		.7788

* Computed according to reference 11.

 [redacted] [redacted]

TABLE 1 (*continued*).

Station	Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
STATION 10; Lat. 53° 17′ N; Long. 179° 12′ E; Date 17 July; Messenger Time — Shallow Cast 0248, Deep Cast 0336; Wire Angle — Shallow Cast 15°, Deep Cast 12°; Depth of Top Bottle (Deep Cast) 237 Meters; Depth to Top of Thermocline 20 Meters; Depths on Deep Cast ±2%	0	7.31	33.13	6.85	0	7.31	33.13	6.85	25.93	4836.4	0
	10	7.30	(33.13)	6.85	10	7.30	33.13	6.85	25.93	4836.9	.0209
	24	5.43	33.13	7.44	20	6.70	33.13	7.41	26.01	4829.7	.0414
	49	3.30	33.26	6.57	30	4.35	33.18	7.39	26.32	4799.0	.0600
	90	2.86	33.35	6.11	40	3.41	33.23	7.01	26.46	4786.8	.0764
	114	2.61	33.35	6.08	50	3.29	33.26	6.54	26.49	4785.8	.0921
	164	3.08	(33.73)	4.44	75	3.03	33.33	6.20	26.57	4784.0	.1299
	237	3.51	33.73	2.83	100	2.77	33.35	6.10	26.61	4781.9	.1633
	384	3.50	(33.98)	1.09	150	2.88	(33.45)	4.81	26.68	4786.8	.2367
	581	3.38	33.87	1.16	200	3.41	(33.66)	3.73	26.80	4798.1	.3029
	791	3.14	34.25	0.43	250	3.52	(33.75)	2.64	26.86	4803.0	.3650
	992	2.84	34.33	0.55	300	3.53	(33.78)	1.91	26.88	4806.3	.4253
	1106	2.70	34.38		400	3.50	(33.80)	1.09	26.90	4812.0	.5444
					500	3.44	33.83	1.16	26.93	4817.3	.6618
					600	3.35	33.89	1.13	26.99	4822.2	.7758
					700	3.25	34.08	0.83	27.15	4827.6	.8803
					800	3.14	34.26	0.42	27.30	4832.7	.9705
					1000	2.83	34.33	0.56	27.39	4840.6	1.1299
					1100	2.71	34.38		27.44	4845.1	1.2039
STATION 11; Lat. 54° 13′ N; Long. 178° 25′ E; Date 17 July; Messenger Time — Shallow Cast 1433, Deep Cast 1531; Wire Angle — Shallow Cast 25°, Deep Cast 10-25°; Depth of Top Bottle (Deep Cast) 141 Meters; Depth to Top of Thermocline 20 Meters; Depths Questionable Below 141 Meters, Based on Wire Angle of 15°	0	7.03	33.18	6.88	0	7.03	33.18	6.88	26.00	4833.0	0
	8	7.01	33.19	6.92	10	7.01	33.19	6.96	26.01	4833.4	.0201
	21	5.90	33.21	7.27	20	6.20	33.20	7.24	26.13	4823.5	.0396
	45	3.82	33.26	7.57	30	4.45	33.23	7.42	26.36	4800.6	.0575
	70	3.79	33.28	7.52	40	3.86	33.25	7.54	26.43	4793.2	.0739
	92	3.02	33.30	7.24	50	3.82	33.26	7.59	26.44	4793.2	.0899
	141	2.57	33.36	6.99	75	3.73	33.28	7.48	26.47	4793.5	.1296
	230	3.49	33.68	3.22	100	2.96	33.31	7.21	26.56	4784.4	.1678
	384	3.54	33.93	1.16	150	2.66	33.39	6.90	26.65	4783.6	.2400
	567	3.33	(33.99)	0.65	200	3.36	33.58	4.30	26.74	4797.1	.3082
					250	3.53	33.73	2.82	26.84	4803.1	.3720
					300	3.55	33.83	2.02	26.92	4806.9	.4318
					400	3.52	33.94	1.09	27.01	4812.9	.5440
					500	3.42	(33.97)	0.81	27.05	4817.7	.6510
					600	3.27	34.00		27.09	4821.5	.7552

* Computed according to reference 11.

STATION 12; Lat. 54° 45′ N; Long. 178° 56′ E; Date 17 July; Messenger Time — Shallow Cast 2102, Deep Cast 2210; Wire Angle — Shallow Cast 0°, Deep Cast 10°; Depth of Top Bottle (Deep Cast) 144 Meters; Depth to Top of Thermocline 26 Meters

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	6.26	33.14	7.06	0	6.26	33.14	7.06	26.07	4822.9	0
10	6.25	33.15	7.24	10	6.25	33.15	7.24	26.08	4822.4	.0194
27	6.14	33.13	7.22	20	6.25	33.14	7.23	26.08	4823.0	.0388
55	2.39	33.13	7.40	30	5.60	33.13	7.22	26.14	4815.8	.0579
82	1.70	33.17	7.36	40	4.00	33.13	7.29	26.32	4794.6	.0759
107	1.65	33.21	7.01	50	2.83	33.13	7.37	26.43	4778.7	.0925
144	2.14	33.28	7.27	75	1.77	33.16	7.37	26.54	4765.1	.1315
243	3.21	33.64	3.46	100	1.66	33.20	7.12	26.57	4765.2	.1687
390	3.52	33.93	1.54	150	2.20	33.29	7.26	26.61	4776.4	.2414
587	3.44	34.02	0.81	200	2.79	33.47	4.26	26.71	4788.6	.3113
693	3.28	34.18	0.66	250	3.25	33.66	3.35	26.82	4798.8	.3767
				300	3.43	33.79	2.68	26.91	4805.0	.4376
				400	3.52	33.94	1.46	27.01	4812.9	.5507
				500	3.52	33.98	1.00	27.04	4819.0	.6579
				600	3.42	34.03	0.79	27.07	4823.8	.7619
				(700)	(3.27)	(34.19)	0.64	27.24	4828.4	.8575

STATION 13; Lat. 55° 33′ N; Long. 179° 50′ E; Date 18 July; Messenger Time — Shallow Cast 0631, Deep Cast 0541; Wire Angle — Shallow Cast 20°, Deep Cast 12°; Depth of Top Bottle (Deep Cast) 146 Meters; Depth to Top of Thermocline 21 Meters; Depths on Deep Cast ±2%

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	7.25	33.17	6.83	0	7.25	33.17	6.83	25.96	4835.9	0
9	7.20	33.15	6.84	10	7.19	33.15	6.84	25.96	4835.6	.0205
23	6.22	33.17	7.27	20	6.85	33.17	7.15	26.02	4831.9	.0408
46	2.52	33.17	7.36	30	5.00	33.17	7.32	26.25	4807.9	.0597
69	2.17	33.24	7.16	40	3.05	33.17	7.36	26.44	4781.4	.0766
91	1.93	33.26	7.18	50	2.47	33.19	7.33	26.51	4773.9	.0923
146	1.41	33.25	7.05	75	2.10	33.25	7.15	26.59	4770.2	.1298
241	3.61	33.73	2.08	100	1.87	33.26	7.16	26.61	4768.5	.1660
390	3.57	34.02	1.00	150	1.44	33.25	7.01	26.64	4765.2	.2373
590	3.37	34.17	0.45	200	2.81	33.48	5.06	26.71	4788.9	.3065
				250	3.64	33.76	1.92	26.86	4804.6	.3707
				300	3.65	33.88	1.59	26.95	4808.5	.4295
				400	3.56	34.03	0.96	27.08	4814.0	.5371
				500	3.45	34.11	0.67	27.16	4818.7	.6358
				600	3.37	34.18	0.43	27.22	4823.8	.7286

* Computed according to reference 11.

TABLE 1 (*continued*).

Station	Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
STATION 14; Lat. 56° 08′ N; Long. 179° 05′ W; Date 18 July; Messenger Time — Shallow Cast 1316, Deep Cast 1348; Wire Angle — Shallow Cast 20°, Deep Cast 10°; Depth of Top Bottle (Deep Cast) 140 Meters; Depth to Top of Thermocline 21 Meters; Depths on Deep Cast ±2%	0	7.14	33.19	6.96	0	7.14	33.19	6.96	26.00	4834.6	0
	10	7.07	33.14	6.90	10	7.07	33.14	6.90	25.96	4834.0	.0203
	24	5.78	33.15	7.08	20	7.05	33.15	7.03	25.98	4834.3	.0407
	49	2.52	33.22	7.15	30	3.85	33.17	7.11	26.37	4792.1	.0592
	74	2.26	33.30	7.29	40	2.93	33.19	7.14	26.47	4779.9	.0754
	102	2.07	33.28	7.13	50	2.51	33.22	7.15	26.53	4774.6	.0908
	140	1.59	33.26	7.08	75	2.27	33.30	7.29	26.61	4772.9	.1277
	236	3.63	33.75	2.56	100	2.10	33.28	7.15	26.61	4771.8	.1637
	381	3.59	33.98	1.26	150	1.61	33.27	6.96	26.64	4767.8	.2350
	573	3.48	34.02	1.02	200	3.03	33.59	3.07	26.78	4792.5	.3025
	777	3.39	34.20	0.80	250	3.65	33.80	2.41	26.89	4805.2	.3644
	993	2.96	34.31	0.76	300	3.65	33.90	1.93	26.97	4808.6	.4221
	1104	2.70	34.41	0.72	400	3.57	33.99	1.20	27.05	4813.8	.5306
					500	3.50	34.00	1.07	27.06	4818.8	.6353
					600	3.48	34.04	1.00	27.10	4824.6	.7384
					700	3.44	34.14	0.88	27.18	4830.6	.8367
					800	3.35	34.21	0.79	27.24	4835.5	.9287
					1000	2.93	34.32	0.75	27.37	4842.1	1.0959
					1100	2.72	34.40	0.72	27.45	4845.4	1.1701
STATION 15; Lat. 56° 42′ N; Long. 177° 50′ W; Date 18 July; Messenger Time — Shallow Cast 2139, Deep Cast 2208; Wire Angle — Shallow Cast 5°, Deep Cast 5°; Depth of Top Bottle (Deep Cast) 136 Meters; Depth to Top of Thermocline 25 Meters; Depths on Deep Cast ±2%	0	7.49	33.04	6.84	0	7.49	33.04	6.84	25.83	4838.4	0
	9	7.42	33.03	6.67	10	7.42	33.03	6.67	25.83	4838.0	.0218
	25	7.36	33.03	6.73	20	7.38	33.03	6.70	25.84	4838.1	.0435
	48	3.06	33.19	7.21	30	4.75	33.10	6.86	26.22	4804.2	.0634
	72	2.63	33.22	6.80	40	3.34	33.17	7.09	26.42	4785.6	.0806
	97	2.49	33.26	6.70	50	3.00	33.19	7.20	26.46	4781.5	.0966
	136	2.40	33.30	6.61	75	2.61	33.23	6.78	26.53	4777.5	.1353
	226	3.53	33.55	3.68	100	2.48	33.26	6.69	26.56	4777.2	.1728
	362	3.62	33.86	2.12	150	2.48	33.33	6.50	26.62	4780.6	.2457
	549	3.41	34.06	1.38	200	3.25	33.46	4.21	26.66	4795.0	.3166
					250	3.58	33.63	3.33	26.76	4803.3	.3845
					300	3.64	33.75	2.76	26.85	4807.8	.4480
					400	3.59	33.91	1.87	26.98	4813.7	.5652
					500	3.47	34.02	1.50	27.08	4818.6	.6720
					550	3.41	34.06	1.38	27.12	4820.8	.7224

* Computed according to reference 11.

STATION 16; Lat. 56° 42' N; Long. 176° 11' W; Date 19 July; Messenger Time — Shallow Cast 0621, Deep Cast 0529; Wire Angle — Shallow Cast 0°, Deep Cast 5°; Depth of Top Bottle (Deep Cast) 403 Meters; Depth to Top of Thermocline 27 Meters

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	7.01	33.16	6.87	0	7.01	33.16	6.87	25.99	4832.6	0
9	7.01	33.13	6.92	10	7.01	33.13	6.92	25.97	4833.1	.0204
25	7.00	33.15	6.90	20	7.00	33.14	6.92	25.98	4833.7	.0408
51	3.51	33.26		30	6.50	33.15	6.91	26.05	4827.8	.0608
73	2.64	33.26	7.18	40	4.65	33.18	6.95	26.29	4803.8	.0794
99	2.39	33.26	7.22	50	3.73	33.26	7.03	26.45	4791.9	.0960
150	2.11	33.31	7.00	75	2.63	33.26	7.21	26.55	4777.8	.1346
249	3.56	33.66	3.35	100	2.38	33.26	7.21	26.57	4775.7	.1717
403		34.02		150	2.11	33.31	7.00	26.63	4775.2	.2441
606	3.36	34.14	0.61	200	2.91	33.43	5.49	26.66	4790.0	.3145
806	3.09	34.25	0.43	250	3.56	33.66	3.34	26.79	4803.2	.3816
1011	2.80	34.36	0.46	300	3.59	33.84	2.73	26.93	4807.5	.4427
1103	2.67	34.40	0.49	400	3.57	34.02	2.01	27.07	4813.9	.5520
				500	3.48	34.08	1.34	27.13	4818.9	.6525
				600	3.37	34.14	0.67	27.19	4823.7	.7482
				700	3.25	34.19	0.46	27.24	4828.1	.8392
				800	3.11	34.25	0.43	27.30	4832.3	.9256
				1000	2.82	34.35	0.46	27.41	4840.6	1.0840
				1100	2.68	34.40	0.49	27.46	4844.7	1.1563

STATION 17; Lat. 55° 52' N; Long. 176° 15' W; Date 19 July; Messenger Time — Shallow Cast 1500, Deep Cast 1401; Wire Angle — Shallow Cast 5°, Deep Cast 12°; Depth of Top Bottle (Deep Cast) 392 Meters; Depth to Top of Thermocline 21 Meters; Depths Questionable from 67 to 286 Meters

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	6.82	32.87	6.82	0	6.82	32.87	6.82	25.79	4829.0	0
10	6.73	32.86	6.94	10	6.73	32.86	6.94	25.79	4828.3	.0222
24	4.93	32.92	7.35	20	6.30	32.90	7.25	25.88	4823.5	.0439
27	4.86	32.94	7.39	30	4.15	32.94	7.38	26.16	4795.3	.0639
48	3.09	32.99	6.87	40	3.31	32.97	7.08	26.26	4784.3	.0821
67	2.82	33.06	6.50	50	3.05	33.00	6.82	26.31	4781.3	.0996
101	3.08	33.21	6.07	75	2.90	33.10	6.40	26.40	4781.2	.1416
179	3.02	33.30	6.17	100	3.08	33.20	6.08	26.46	4785.5	.1818
286	3.55	33.58	4.03	150	3.02	33.27	6.12	26.53	4788.1	.2593
392		33.73		200	3.06	33.38	5.83	26.61	4792.0	.3335
586	3.51	34.07	1.31	250	3.35	33.50	4.70	26.68	4799.6	.4043
781		34.27	0.58	300	3.58	33.60	3.79	26.74	4806.2	.4723
977	2.88	34.40	0.48	400	3.64	33.75	2.77	26.85	4813.8	.6009
1075	2.77	34.43	0.55	500	3.60	33.93	1.94	27.00	4819.9	.7180
				600	3.59	34.08	1.24	27.12	4825.9	.8233
				700	3.35	34.19	0.84	27.23	4829.5	.9184
				800	3.19	34.28	0.53	27.32	4833.5	1.0046
				1000	2.92	34.41	0.50	27.44	4842.4	1.1582
				1100	2.73	34.44	0.57	27.48	4845.0	1.2276

* Computed according to reference 11.

TABLE 1 (continued).

	Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
STATION 18; Lat. 55° 21′ N; Long. 177° 24′ W; Date 19-20 July; Messenger Time — Shallow Cast 0041, Deep Cast 2343; Wire Angle — Shallow Cast 0°, Deep Cast 20°; Depth of Top Bottle (Deep Cast) 384 Meters; Depth to Top of Thermocline 24 Meters	0	7.20	33.10	6.69	0	7.20	33.10	6.69	25.92	4834.9	0
	10	7.14	33.12	6.64	10	7.14	33.12	6.64	25.94	4834.9	.0208
	26	6.78	33.15	6.85	20	7.00	33.14	6.76	25.98	4833.7	.0414
	50	2.80	33.19	7.36	30	6.00	33.16	6.95	26.12	4821.2	.0611
	75	2.58	33.28	7.19	40	3.35	33.17	7.21	26.42	4785.7	.0787
	100	2.44	33.28	7.04	50	2.80	33.19	7.36	26.48	4778.6	.0946
	151	2.66	33.33	6.43	75	2.58	33.28	7.19	26.57	4777.2	.1326
	251	3.63	33.76	2.16	100	2.44	33.28	7.04	26.58	4776.7	.1694
	384	3.60	33.96	1.08	150	2.66	33.33	6.45	26.60	4783.2	.2422
	584	3.36	34.14	0.58	200	3.23	33.45	4.48	26.65	4794.7	.3136
	781	3.10	34.27	0.42	250	3.62	33.75	2.21	26.85	4804.6	.3795
	978	2.83	34.36	0.53	300	3.66	33.89	1.67	26.96	4808.8	.4383
	1078	2.73	34.38	0.52	400	3.59	33.97	1.02	27.03	4814.0	.5481
					500	3.48	34.06	0.72	27.11	4818.8	.6513
					600	3.35	34.15	0.56	27.20	4823.3	.7473
					700	3.24	34.22	0.45	27.26	4828.0	.8368
					800	3.06	34.28	0.43	27.33	4831.7	.9206
					1000	2.80	34.37	0.53	27.42	4840.4	1.0746
					1100	2.71	34.38	0.52	27.44	4845.1	1.1470
STATION 19; Lat. 54° 44′ N; Long. 178° 45′ W; Date 20 July; Messenger Time — Shallow Cast 0959, Deep Cast 0905; Wire Angle — Shallow Cast 5°, Deep Cast 4°; Depth of Top Bottle (Deep Cast) 399 Meters; Depth to Top of Thermocline 21 Meters	0	7.11	33.11	6.76	0	7.11	33.11	6.76	25.94	4833.8	0
	10	7.08	33.08	6.76	10	7.08	33.08	6.76	25.92	4833.8	.0208
	24	5.55	33.17	7.33	20	7.05	33.16	7.25	25.99	4834.3	.0414
	50	2.83	33.22	7.27	30	4.35	33.18	7.33	26.33	4799.0	.0601
	75	2.23	(33.24)	7.18	40	3.33	33.20	7.30	26.44	4785.5	.0766
	100	2.12	33.26	7.08	50	2.83	33.22	7.27	26.50	4779.1	.0923
	150	1.86	33.28	6.90	75	2.23	33.24	7.18	26.57	4772.1	.1301
	249	3.64	33.80	1.89	100	2.12	33.26	7.08	26.60	4772.1	.1667
	399	3.58	34.02	0.84	150	1.86	33.28	6.90	26.63	4771.4	.2386
	599	3.36	34.19	0.46	200	3.20	33.55	4.49	26.73	4794.7	.3074
	799	3.09	34.31	0.38	250	3.64	33.80	1.88	26.89	4805.0	.3704
	1000	2.78	34.40	0.42	300	3.64	33.89	1.42	26.96	4808.4	.4283
	1101	2.67	34.43	0.45	400	3.58	34.02	0.83	27.07	4814.0	.5361
					500	3.50	34.12	0.57	27.16	4819.4	.6352
					600	3.36	34.19	0.46	27.22	4823.7	.7276
					700	3.23	34.25	0.42	27.29	4828.0	.8144
					800	3.09	34.31	0.38	27.34	4832.2	.8960
					1000	2.78	34.40	0.42	27.45	4840.2	1.0456
					1100	2.67	34.43	0.45	27.48	4844.9	1.1147

* Computed according to reference 11.

STATION 20; Lat. 53° 57′ N; Long. 178° 34′ W; Date 20 July; Messenger Time — Shallow Cast 1748, Deep Cast 1659; Wire Angle — Shallow Cast 5°, Deep Cast 5°; Depth of Top Bottle (Deep Cast) 401 Meters; Depth to Top of Thermocline 29 Meters; Temperature at 150 Meters Interpolated Using BT

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. (⁰/₀₀)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. (⁰/₀₀)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	6.80	33.14	6.83	0	6.80(E)	33.14	6.83	26.00	4829.6	0
10	6.74	33.13	6.79	10	6.74	33.13	6.79	26.00	4829.6	.0201
25	6.59	33.15	6.94	20	6.66	33.14	6.87	26.02	4829.3	.0402
50	2.87	33.22	7.29	30	6.50	33.16	7.02	26.06	4827.8	.0600
75	2.18	33.27	7.18	40	4.65	33.19	7.17	26.30	4803.9	.0785
101	2.19	33.28	6.90	50	2.87	33.22	7.29	26.50	4779.8	.0949
150	(1.96)	33.31	6.71	75	2.18	33.27	7.18	26.59	4771.6	.1324
250	3.64	33.78	2.00	100	2.19	33.28	6.91	26.60	4773.3	.1686
401	3.55	34.04	0.88	150	1.96	33.31	6.71	26.64	4773.0	.2399
600		34.22	0.43	200	3.11	33.58	4.76	26.77	4793.5	.3076
800	3.03	34.33	0.46	250	3.64	33.78	2.00	26.88	4804.9	.3702
1001	2.76	34.42	0.44	300	3.64	33.88	1.32	26.95	4808.3	.4286
1102	2.64	n.s.		400	3.55	34.04	0.89	27.09	4813.7	.5358
				500	3.45	34.14	0.53	27.18	4818.9	.6330
				600	3.34	34.22	0.43	27.25	4823.6	.7232
				700	3.18	34.28	0.45	27.31	4827.4	.8074
				800	3.03	34.33	0.46	27.37	4831.5	.8866
				1000	2.76	34.42	0.44	27.46	4840.1	1.0324
				1100	2.64	34.44		27.49	4844.4	1.1001

STATION 21; Lat. 53° 22′ N; Long. 178° 13′ W; Date 20 July; Messenger Time — Shallow Cast 2308, Deep Cast 2223; Wire Angle — Shallow Cast 5°, Deep Cast 20°; Depth of Top Bottle (Deep Cast) 383 Meters; Depth to Top of Thermocline 49 Meters

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. (⁰/₀₀)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. (⁰/₀₀)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	6.50	33.19	6.74	0	6.50	33.19	6.74	26.08	4826.2	0
10	6.26	33.17	6.75	10	6.26	33.17	6.75	26.10	4823.6	.0193
25	6.18	33.19	6.94	20	6.20	33.18	6.82	26.12	4823.4	.0385
50	5.30	33.26	6.41	30	6.12	33.20	6.92	26.14	4823.0	.0575
75	4.07	33.39	5.02	40	5.75	33.23	6.69	26.21	4818.8	.0760
100	3.17	33.40	5.67	50	5.30	33.26	6.41	26.29	4813.4	.0939
150	3.66	33.53	4.41	75	4.07	33.39	5.02	26.52	4798.9	.1349
250	3.60	(33.53)	(4.65)	100	3.17	33.40	5.67	26.62	4787.8	.1719
383	3.48	33.94	1.78	150	3.66	33.53	4.41	26.67	4798.2	.2425
580	3.29	34.14	0.97	200	3.64	33.63	3.54	26.76	4801.2	.3100
776	3.16	34.27	0.32	250	3.60	33.71	2.98	26.82	4804.0	.3742
962	2.85	34.36	0.59	300	3.56	33.80	2.48	26.90	4806.9	.4351
1081	2.77	34.38	0.47	400	3.48	33.96	1.68	27.03	4812.3	.5475
				500	3.40	34.07	1.25	27.12	4817.9	.6497
				600	3.32	34.16	0.90	27.21	4822.8	.7443
				700	3.23	34.23	0.53	27.28	4828.0	.8328
				800	3.12	34.28	0.31	27.32	4832.6	.9166
				1000	2.81	34.37	0.47	27.42	4840.6	1.0714
				1100	2.76	34.38	0.32	27.44	4846.0	1.1438

* Computed according to reference 11.

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TABLE 1 (*continued*).

Station	Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
STATION 22; Lat. 52° 39′ N; Long. 177° 07′ W; Date 21 July; Messenger Time — Shallow Cast 0826, Deep Cast 0736; Wire Angle — Shallow Cast 12°, Deep Cast 5°; Depth of Top Bottle (Deep Cast) 399 Meters; Depth to Top of Thermocline 30 Meters	0	6.42	33.20	6.91	0	6.42	33.20	6.91	26.10	4825.2	
	9	6.31	33.22	6.92	10	6.30	33.22	6.92	26.13	4824.3	.0191
	26	6.14	33.22	6.94	20	6.17	33.22	6.93	26.15	4823.2	.0379
	50	3.95	33.37	5.73	30	5.89	33.22	6.92	26.18	4820.0	.0565
	73	3.80	33.48	5.42	40	4.30	33.27	6.37	26.40	4799.3	.0739
	101	3.66	33.51	5.06	50	3.95	33.37	5.73	26.44	4795.1	.0897
	150	2.76	33.52	5.07	75	3.80	33.48	5.39	26.62	4795.4	.1267
	250	3.54	33.775	2.98	100	3.66	33.51	5.07	26.66	4795.1	.1621
	399	3.50	34.02	1.56	150	2.76	33.52	5.07	26.75	4785.5	.2299
	598	3.34	34.22	0.79	200	3.17	33.64	4.10	26.81	4794.7	.2943
	797	3.04	34.34	0.70	250	3.54	33.78	2.98	26.89	4803.5	.3557
	999	2.83	34.40	0.55	300	3.55	33.88	2.40	26.96	4807.0	.4136
	1100	2.71	34.43	0.55	400	3.50	34.02	1.55	27.08	4812.9	.5208
					500	3.43	34.13	1.08	27.17	4818.6	.6188
					600	3.34	34.22	0.79	27.25	4823.5	.7093
					700	3.20	34.29	0.74	27.32	4827.8	.7933
					800	3.04	34.34	0.69	27.38	4831.7	.8719
					1000	2.83	34.40	0.55	27.44	4840.9	1.0191
					1100	2.71	34.43	0.55	27.48	4845.4	1.0886
STATION 23; Lat. 52° 26′ N; Long. 175° 34′ W; Date 24 July; Messenger Time — Shallow Cast 0240, Deep Cast 0151; Wire Angle — Shallow Cast 3°, Deep Cast 3°; Depth of Top Bottle (Deep Cast) 405 Meters; Depth to Top of Thermocline 6 Meters	0	7.03	33.125	6.78	0	7.03	33.125	6.78	25.96	4832.9	0
	9	6.49	33.13	6.80	10	6.00	33.13	6.80	26.10	4819.9	.0199
	25	5.02	33.28	5.82	20	5.18	33.25	6.01	26.29	4810.0	.0382
	50	4.61	33.30	5.42	30	4.89	33.29	5.72	26.35	4805.9	.0553
	76	4.45	33.35	5.30	40	4.68	33.29	5.55	26.38	4804.6	.0720
	100	4.36	33.35	5.17	50	4.61	33.30	5.42	26.40	4804.0	.0885
	151	4.14	33.395	4.99	75	4.45	33.35	5.31	26.45	4803.9	.1290
	250	3.70	33.46	4.58	100	4.36	33.35	5.17	26.46	4804.2	.1688
	405	3.54	33.84	2.16	150	4.14	33.39	5.00	26.52	4804.3	.2470
	605	3.38	34.09	0.66	200	3.80	33.42	4.83	26.58	4802.6	.3226
	805	3.15	34.21	0.42	250	3.70	33.46	4.58	26.62	4804.3	.3960
	1008	2.86	34.33	0.56	300	3.57	33.53	3.86	26.68	4805.8	.4669
	1109	2.73	34.36	0.58	400	3.55	33.82	2.23	26.92	4812.3	.5951
					500	3.48	33.98	1.39	27.04	4818.4	.7067
					600	3.40	34.09	0.69	27.15	4823.9	.8081
					700	3.29	34.15	0.46	27.21	4828.5	.9029
					800	3.17	34.20	0.42	27.25	4833.0	.9931
					1000	2.86	34.33	0.56	27.39	4841.1	1.1577
					1100	2.75	34.36	0.58	27.42	4845.6	1.2328

* Computed according to reference 11.

STATION 24; Lat. 53° 11′ N; Long. 174° 25′ W; Date 24 July; Messenger Time — Shallow Cast 1112, Deep Cast 0935; Wire Angle — Shallow Cast 8°, Deep Cast 3°; Depth of Top Bottle (Deep Cast) 401 Meters; Depth to Top of Thermocline 9 Meters

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	7.63	33.17	6.89	0	7.63	33.17	6.89	25.91	4841.0	0
10	7.53	33.12	6.82	10	7.53	33.12	6.82	25.89	4839.8	.0211
25	7.01	33.17	6.90	20	7.29	33.15	6.88	25.94	4837.4	.0421
50	4.27	33.21	6.89	30	6.20	33.18	6.90	26.11	4824.0	.0620
75	3.69	33.24	6.25	40	5.13	33.20	6.89	26.26	4810.3	.0804
100	3.33	33.30	6.26	50	4.27	33.21	6.89	26.36	4799.1	.0977
150	2.94	33.30	6.12	75	3.69	33.24	6.25	26.44	4792.9	.1387
250	3.30	33.49	4.85	100	3.33	33.30	6.26	26.52	4789.5	.1778
401	3.62	33.82	2.06	150	2.94	33.30	6.12	26.56	4787.0	.2533
602	3.42	34.14	0.75	200	3.03	33.38	5.53	26.61	4791.6	.3268
800	3.20	34.22	0.58	250	3.30	33.49	4.85	26.68	4798.9	.3976
1001	2.93	34.33	0.43	300	3.49	33.61	3.85	26.75	4805.0	.4653
1102	2.78	34.40	0.42	400	3.62	33.82	2.07	26.91	4813.9	.5905
				500	3.59	34.00	1.31	27.05	4820.1	.7023
				600	3.43	34.14	0.76	27.18	4824.5	.8019
				700	3.32	34.19	0.59	27.23	4829.1	.8937
				800	3.20	34.22	0.58	27.26	4833.5	.9820
				1000	2.93	34.33	0.43	27.38	4842.1	1.1460
				1100	2.78	34.40	0.42	27.45	4846.2	1.2201

STATION 25; Lat. 54° 01′ N; Long. 174° 41′ W; Date 24 July; Messenger Time — Shallow Cast 2200, Deep Cast 2038; Wire Angle — Shallow Cast 0°, Deep Cast 5°; Depth of Top Bottle (Deep Cast) 401 Meters; Depth to Top of Thermocline 18 Meters

Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
0	7.43	33.06	6.96	0	7.43	33.06	6.96	25.85	4837.6	0
10	7.36	33.08	6.79	10	7.36	33.08	6.79	25.88	4837.5	.0214
25	5.80	33.15	7.14	20	7.21	33.11	6.97	25.92	4836.3	.0425
76	2.52	33.28		30	5.35	33.17	7.14	26.21	4812.6	.0621
101	2.45	33.28	6.83	40	3.90	33.21	7.11	26.40	4793.5	.0794
152	3.03	33.44	5.22	50	2.90	33.24	7.07	26.51	4780.3	.0953
210	3.52	33.72	3.15	75	2.52	33.28	6.97	26.58	4776.4	.1329
251	3.60	33.78	2.63	100	2.45	33.28	6.86	26.59	4776.9	.1696
401	3.60	34.00	0.93	150	3.01	33.44	5.30	26.67	4788.7	.2411
602	3.29	34.16	0.71	200	3.43	33.69	3.35	26.82	4798.6	.3071
801	3.03	34.27	0.69	250	3.60	33.78	2.64	26.88	4804.3	.3683
1003	2.78	34.38	0.52	300	3.63	33.85	2.06	26.93	4808.0	.4271
1104	2.64	34.39	0.69	400	3.60	34.00	0.93	27.05	4814.2	.5371
				500	3.48	34.09	0.71	27.13	4819.0	.6381
				600	3.30	34.16	0.71	27.21	4822.6	.7323
				700	3.16	34.21	0.70	27.26	4826.8	.8211
				800	3.04	34.27	0.69	27.32	4831.4	.9051
				1000	2.79	34.38	0.57	27.43	4840.3	1.0587
				1100	2.65	34.39	0.68	27.45	4844.4	1.1299

* Computed according to reference 11.

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TABLE 1 (*continued*).

Station	Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
STATION 26; Lat. 54° 54′ N; Long 174° 41′ W; Date 25 July; Messenger Time — Shallow Cast 0911, Deep Cast 0820; Wire Angle — Shallow Cast 0°, Deep Cast 10°; Depth of Top Bottle (Deep Cast) 398 Meters; Depth to Top of Thermocline 27 Meters	0	7.53	33.11	6.64	0	7.53	33.11	6.64	25.88	4838.9	0
	10	7.49	33.12	6.59	10	7.49	33.12	6.59	25.89	4839.3	.0212
	24	7.48	33.13		20	7.48	33.13	6.61	25.90	4839.7	.0423
	50	3.55	33.30	6.73	30	7.48	33.13	6.66	25.90	4840.3	.0634
	75	2.93	33.33	6.36	40	5.56	33.22	6.69	26.22	4816.3	.0830
	100		33.31	6.54	50	3.55	33.30	6.73	26.50	4789.6	.0998
	150	2.79	33.37	5.84	75	2.93	33.32	6.36	26.57	4782.6	.1375
	250	3.61	33.68	3.19	100	2.65	33.33	6.54	26.61	4780.1	.1740
	398	3.57	33.92	1.57	150	2.79	33.37	5.84	26.63	4785.3	.2458
	599	3.34	34.11	0.74	200	3.42	33.51	4.54	26.68	4797.7	.3161
	797	3.12	34.25	0.55	250	3.61	33.68	3.19	26.80	4804.0	.3826
	996	2.87	34.33	0.64	300	3.64	33.80	2.56	26.89	4808.0	.4444
	1096	2.75	34.36	0.52	400	3.57	33.92	1.56	27.00	4813.5	.5592
					500	3.47	34.02	1.06	27.09	4818.6	.6656
					600	3.34	34.11	0.73	27.17	4823.0	.7645
					700	3.24	34.19	0.58	27.24	4827.9	.8566
					800	3.12	34.25	0.55	27.29	4832.5	.9430
					1000	2.86	34.33	0.64	27.39	4841.1	1.1034
					1100	2.75	34.36	0.51	27.42	4845.6	1.1784
STATION 27; Lat. 55° 14′ N; Long. 173° 00′ W; Date 25 July; Messenger Time — Shallow Cast 1926, Deep Cast 1814; Wire Angle — Shallow Cast 9°, Deep Cast 15-25°; Depth of Top Bottle (Deep Cast) 397 Meters; Depth to Top of Thermocline 37 Meters; Data Questionable Below 600 Meters Because of Changing Wire Angle	0	7.79	32.745	7.05	0	7.79	32.74	7.05	25.55	4840.6	0
	10	7.72	32.74	7.04	10	7.76	32.74	7.04	25.56	4841.2	.0244
	24	7.74	33.15	6.76	20	7.74	33.13	6.80	25.87	4843.1	.0473
	50	6.86	33.15	(7.04)	30	7.65	33.15	6.72	25.89	4842.7	.0686
	75	3.56	33.22	6.72	40	7.50	33.15	6.72	25.91	4841.3	.0897
	100	3.04	33.24	6.51	50	6.86	33.15	6.72	26.01	4833.8	.1103
	150	2.83	33.30	6.35	75	3.56	33.22	6.72	26.44	4791.0	.1556
	250	3.32	33.48	5.14	100	3.04	33.24	6.51	26.50	4785.2	.1950
	397	3.61	33.77	2.38	150	2.83	33.30	6.35	26.57	4785.4	.2707
	594	3.45	34.05	0.85	200	2.83	33.35	5.80	26.61	4788.6	.3440
	788		(34.20)		250	3.32	33.48	5.14	26.67	4799.1	.4152
	987	(2.93)	(34.23)		300	3.54	33.59	3.99	26.73	4805.7	.4837
	1076	(2.78)	(34.32)		400	3.61	33.78	2.35	26.88	4813.5	.6113
	(Doubtful because of changing wire				500	3.56	33.93	1.48	27.00	4819.4	.7269
	angle after messenger dropped)				600	3.44	34.06	0.82	27.12	4824.2	.8319

* Computed according to reference 11.

Station	Depth of Bottle (meters)	Obs. Temp. (° C)	Obs. Sal. ($^0/_{00}$)	Obs. Dissolved Oxygen (ml/l)	Standard Depths (meters)	Interpolated Temp. (° C)	Interpolated Sal. ($^0/_{00}$)	Interpolated Dissolved Oxygen (ml/l)	σ_t	Sound Vel. (feet/sec)*	ΔD (dynamic meters)*
STATION 28; Lat. 56° 00′ N; Long. 171° 54′ W; Date 26 July; Messenger Time — Shallow Cast 0556, Deep Cast 0610; Wire Angle — Shallow Cast 0°, Deep Cast 3°; Depth of Top Bottle (Deep Cast) 401 Meters; Depth to Top of Thermocline 12 Meters	0	8.11	32.70	7.90	0	8.11	32.70	7.90	25.47	4844.8	0
	10	8.08	32.70	7.68	10	8.08	32.70	7.68	25.48	4845.0	.0251
	24	7.34	32.65	6.80	20	7.95	32.66	6.93	25.47	4843.8	.0503
	50	4.64	33.13	6.13	30	7.00	32.74	6.58	25.66	4832.6	.0746
	75	3.93	33.24	5.81	40	6.21	33.03	6.33	25.99	4824.1	.0964
	100	3.56	33.22	5.47	50	4.64	33.13	3.13	26.26	4804.0	.1154
	150	3.30	33.36	5.28	75	3.93	33.24	5.81	26.42	4796.2	.1580
	249	3.51	33.51	4.01	100	3.56	33.22	5.47	26.45	4792.5	.1984
	401	3.62	33.75	2.48	150	3.30	33.36	5.28	26.57	4792.4	.2756
	603	3.37	34.07	1.22	200	3.43	33.43	4.35	26.62	4797.5	.3487
	804	3.08	34.23	0.77	250	3.51	33.51	4.00	26.68	4801.9	.4196
	1008	2.81	34.33	0.66	300	3.55	33.59	3.48	26.73	4805.8	.4880
	1109	2.65	34.38	0.71	400	3.62	33.75	2.48	26.86	4813.6	.6168
					500	3.51	33.91	1.81	26.99	4818.6	.7341
					600	3.38	34.07	1.24	27.12	4823.4	.8389
					700	3.23	34.17	0.90	27.23	4827.6	.9333
					800	3.08	34.23	0.77	27.29	4831.7	1.0209
					1000	2.81	34.32	0.65	27.38	4840.4	1.1825
					1100	2.66	34.38	0.70	27.44	4844.4	1.2565
STATION 29; Lat. 56° 24′ N; Long. 171° 18′ W; Date 26 July; Messenger Time — Shallow Cast 1135; Wire Angle — Shallow Cast 20-10°; Depth to Top of Thermocline 15 Meters; Wire Angle Decreasing While Messenger Going Down	0	7.72	32.52	7.78	0	7.72	32.52	7.78	25.39	4839.2	0
	10	7.69	32.50	7.81	10	7.69	32.50	7.81	25.38	4839.2	.0260
	25	4.40	32.54	6.87	20	7.00	32.52	7.10	25.49	4831.1	.0516
	48	3.75	32.83		30	4.18	32.56	6.66	25.85	4794.0	.0749
	74	3.46	33.01	5.59	40	3.90	32.72	6.20	26.01	4791.5	.0957
	98	3.63	33.10	5.64	50	3.73	32.85	5.86	26.13	4790.2	.1152
	146	3.36	33.22	5.37	75	3.46	33.01	5.58	26.28	4788.7	.1608
	235	3.09	33.39	5.38	100	3.63	33.11	5.64	26.35	4792.9	.2039
	369	3.62	33.775	2.83	150	3.35	33.23	5.37	26.47	4792.5	.2859
	549	3.45	34.02	1.15	200	3.17	33.29	5.38	26.53	4792.9	.3636
					250	3.21	33.48	5.36	26.68	4797.5	.4364
					300	3.48	33.64	4.46	26.78	4805.0	.5035
					400	3.62	33.83	2.39	26.92	4813.9	.6271
					500	3.52	33.96	1.54	27.03	4818.9	.7397
					550	3.45	34.02	1.14	27.08		.7923
STATION 30; Lat. 56° 42′ N; Long. 170° 53′ W; Date 26 July; Messenger Time — Shallow Cast 1607, Deep Cast 1633; Wire Angle — Shallow Cast 13°; Depth to Top of Thermocline 9 Meters	0	7.66	32.33	7.91	0	7.66	32.33	7.91	25.25	4837.5	0
	10	7.59	32.33	8.05	10	7.59	32.33	8.05	25.25	4837.2	.0273
	20	7.09	32.32	7.68	20	7.09	32.32	7.68	25.32	4831.4	.05[illegible]
	28	5.96	32.34		30	5.60	32.35	7.38	25.53	4812.5	.0798
	49	3.28	32.47	6.93	40	3.36	32.42	7.12	25.82	4782.7	.1031
	86	3.07	32.72	6.02	50	3.27	32.47	6.92	25.87	4782.2	.1248
	100		32.90	5.58	75	3.11	32.62	6.28	26.01	4782.1	.1768
					100	3.05(E)	32.90	5.58	26.23	4783.8	.2246

* Computed according to reference 11.

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TABLE 2. Sea-Surface and Meteorological Observations, Deep Bering Sea, Summer 1949

Lat.	Long.	Date	Time (GCT)	Surface Sal. ($^0/_{00}$)	Surface Temp. (° F)	BT No.*	Oceanog. Sta. No.	Weather	Clouds		Wind		Air Temp. (° F)**		Sea† State	Vis.†
									Form	Tenths	Dir.	Force	Dry	Wet		
54° 24′ N	164° 13′ W	10 Jul	0335	31.36	47.1	1	1	Light rain			045	2	53.0	49.0	3	5
54° 58′ N	166° 20′ W	10 Jul	1345	31.96	49.1	2	2	Overcast	Sc	10	025	1	49.0	47.0	0	8
54° 56′ N	168° 38′ W	11 Jul	0220	32.56	49.0	3	4	Light drizzle	St	10	315	1	48.0	45.0	1	6
54° 54′ N	169° 47′ W	11 Jul	0845	33.04	46.9	4	5	Light rain	Ns	10	315	2	47.0	47.0	1	7
54° 23′ N	170° 55′ W	11 Jul	1543	33.05	45.9	5	6	Overcast	Sc	10	315	3	50.0	46.0	2	8
53° 48′ N	172° 13′ W	11 Jul	2215	33.04	47.0	6		Overcast	Sc	10	315	3	54.0	49.0	2	8
53° 36′ N	172° 45′ W	12 Jul	0058	33.04	47.0	7		Overcast	Sc	10	290	4	50.0	48.0	2	8
53° 24′ N	173° 20′ W	12 Jul	0406	33.10	47.0	8		Overcast	Sc	10	270	2	50.0	45.0	2	8
53° 12′ N	173° 57′ W	12 Jul	0708	33.13	46.9	9		Overcast	Sc	10	225	1	47.0	43.0	1	8
53° 00′ N	174° 31′ W	12 Jul	1000	33.06	47.0	10		Overcast	Sc	10	270	1	46.0	42.0	1	8
52° 48′ N	175° 05′ W	12 Jul	1300	33.10	46.0	11		Overcast	Sc	10	225	2	45.0	43.0	3	7
52° 37′ N	175° 37′ W	12 Jul	1600	33.15	45.8	12		Overcast	Sc	10	135	3	48.0	47.0	2	8
52° 06′ N	176° 32′ W	15 Jul	2105	33.23	43.6	13		Overcast	Cs	10	140	2	50.0	46.0	1	8
52° 21′ N	176° 43′ W	15 Jul	2309	33.12	45.3	14		Overcast	As	10	230	4	46.0	45.0	3	8
52° 37′ N	177° 14′ W	16 Jul	0300	33.18	45.6	15	7	Overcast	As	10	160	4	47.5	45.0	3	7
52° 49′ N	177° 28′ W	16 Jul	0500	33.16	44.7	16		Overcast	As	10	160	3	49.0	46.0	3	7
53° 05′ N	177° 44′ W	16 Jul	0700	32.99	44.5	17		Light rain	Ns	10	090	4	47.0	47.0	4	6
53° 24′ N	178° 05′ W	16 Jul	1030	33.13	43.6	18		Light rain	Ns	10	140	7	45.0	45.0	6	6
53° 22′ N	178° 34′ W	16 Jul	1300	33.13	44.5	19		Light rain	Ns	10	190	7	44.4	44.2	6	6
53° 20′ N	178° 58′ W	16 Jul	1500	33.12	44.1			Light rain	Ns	10	270	7			6	

* Cruise no. 606, assigned by SIO Bathythermograph Processing Section.

** Commencing at BT no. 13, air temperatures were taken with a motor-driven aspirating psychrometer. Probable accuracy of temperature differences between dry and wet bulb: ±0.3° F.

† International Code.

Lat.	Long.	Date	Time (GCT)	Surface Sal. ($^0/_{00}$)	Surface Temp. (° F)	BT No.*	Oceanog. Sta. No.	Weather	Clouds		Wind		Air Temp. (° F)**		Sea†	†
									Form	Tenths	Dir.	Force	Dry	Wet	State	Vis.
53° 19′ N	179° 19′ W	16 Jul	1700	33.17	43.8			Overcast	Sc	10	210	6			3	8
53° 17′ N	179° 38′ W	16 Jul	2015	33.15	43.8	20	9	Overcast	Sc	10	210	5	45.0	44.0	3	8
53° 17′ N	179° 48′ E	16 Jul	2300	33.19	43.4	21		Overcast	Sc	10	220	5	44.6	44.6	3	7
53° 17′ N	179° 22′ E	17 Jul	0101	33.13	43.3	22		Overcast	Sc	10	230	5	46.0	45.5	3	8
53° 17′ N	179° 12′ E	17 Jul	0225	33.13	45.2	23	10	Overcast	Sc	10	250	6	45.6	44.8		8
53° 28′ N	178° 47′ E	17 Jul	0700	33.10	45.2	24		Overcast	Sc	10	230	5	45.6	45.0		8
53° 39′ N	178° 36′ E	17 Jul	0900	33.13	44.7	25		Overcast	Sc	10	220	5	45.6	45.0		5
53° 59′ N	178° 31′ E	17 Jul	1100	33.13	44.8	26		Overcast		10	240	3	45.0	44.5		
54° 13′ N	178° 25′ E	17 Jul	1430	33.18	44.7	27	11	Overcast	Sc	10	220	5	45.0	45.0		
54° 30′ N	178° 41′ E	17 Jul	1802	33.12	43.5	28		Light drizzle	St	10	250	2	45.0	44.0	3	5
								Overcast	Sc							
54° 45′ N	178° 56′ E	17 Jul	2057	33.14	43.3	29	12	with breaks	Ac	9+	300	2	45.2	44.8	3	6
55° 03′ N	179° 16′ E	18 Jul	0100	33.11	44.5	30		Overcast	St	10	250	3	45.6	44.6	3	7
55° 16′ N	179° 32′ E	18 Jul	0300	33.13	44.1	31		Overcast	St	10	300	4	45.5	44.6	3	8
55° 33′ N	179° 50′ E	18 Jul	0630	33.17	45.0	32	13	Overcast	St	10	290	2	47.0	45.0	3	8
55° 46′ N	179° 46′ W	18 Jul	0905	33.13	45.0	33		Overcast	Sc	10	290	2	45.5	45.0	3	8
55° 57′ N	179° 26′ W	18 Jul	1100	33.17	44.9	34		Overcast	Sc	10	290	2	45.5	44.8	3	8
56° 08′ N	179° 05′ W	18 Jul	1300	33.19	44.9	35	14	Overcast	Sc, As	10	270	5	45.7	44.6	3	8
56° 20′ N	178° 38′ W	18 Jul	1630	33.15	45.1	36		Overcast	Sc	10	270	5	45.0	44.5	3	8
56° 30′ N	178° 17′ W	18 Jul	1830	33.10	45.2	37		Overcast	Sc	10	270	5	46.0	44.2	3	8
56° 42′ N	177° 50′ W	18 Jul	2130	33.04	45.5	38	15	Overcast	Sc	10	260	5	45.5	44.8	4	8
56° 42′ N	177° 13′ W	19 Jul	0102	33.03	45.1	39		Overcast	Sc	10	260	5	48.2	45.5	3	8
56° 42′ N	176° 43′ W	19 Jul	0300	33.04	45.4	40		Overcast	Sc	10	240	2	48.0	45.5	3	8
56° 42′ N	176° 11′ W	19 Jul	0635	33.16	45.0	41	16	Overcast	Sc	10	240	4	47.0	45.0	4	8
56° 25′ N	176° 11′ W	19 Jul	0900	33.01	44.2	42		Overcast	Sc	10	240	5	46.0	44.5	4	7
56° 10′ N	176° 12′ W	19 Jul	1100	32.92	44.2	43		Overcast	Sc	10	230	4	45.0	44.0	3	6
55° 52′ N	176° 15′ W	19 Jul	1502	32.87	44.3	44	17	Light drizzle	St	10	190	3	44.3	44.0	3	6
55° 43′ N	176° 34′ W	19 Jul	1732	32.72	44.3	45		Light rain	Ns	10	150	4	44.5	44.0	4	6
55° 35′ N	176° 53′ W	19 Jul	1920	32.83	44.8	46		Light drizzle	Ns	10	220	4	46.0	46.0	4	6
55° 27′ N	177° 11′ W	19 Jul	2130	33.10	45.0	47		Light drizzle	Ns	10	230	4	45.5	45.5	3	6
55° 21′ N	177° 24′ W	20 Jul	0020	33.10	45.3	48	18	Light drizzle	Ns	10	220	3	46.0	46.0	3	6
55° 10′ N	177° 50′ W	20 Jul	0330	33.11	44.7	49		Light fog	St	10	240	4	46.0	45.5	3	6
54° 57′ N	178° 17′ W	20 Jul	0600	33.08	44.7	50		Light fog	St	10	220	3	46.0	46.0	3	5
54° 44′ N	178° 45′ W	20 Jul	1010	33.11	44.8	51	19	Drizzle & fog	Ns	10	230	3	45.5	45.5	3	2
54° 32′ N	178° 42′ W	20 Jul	1205	33.15	44.5	52		Drizzle & fog	Ns	10	230	3	44.9	44.9	3	2
54° 17′ N	178° 38′ W	20 Jul	1400	33.19	44.3	53					230	3	46.0	44.0	3	
53° 57′ N	178° 34′ W	20 Jul	1800	33.14	44.2	54	20	Light drizzle	Ns	10	230	3	44.5	44.5	3	5
53° 40′ N	178° 24′ W	20 Jul	2000	33.19	44.2	55		Overcast	St	10	190	2	43.9	43.9	3	6
53° 22′ N	178° 13′ W	20 Jul	2320	33.19	44.0	56	21	Overcast	St	10	200	2	45.0	45.0	3	5
53° 07′ N	177° 51′ W	21 Jul	0141	33.22	44.9	57		Fog	St	10	220	2	45.0	45.0	3	1
52° 51′ N	177° 25′ W	21 Jul	0431	33.21	44.0	58		Fog	St	10	150	2	44.5	44.5	3	1

* Cruise no. 606, assigned by SIO Bathythermograph Processing Section.

** Commencing at BT no. 13, air temperatures were taken with a motor-driven aspirating psychrometer. Probable accuracy of temperature differences between dry and wet bulb: ±0.3° F.

† International Code.

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TABLE 2 (*continued*)

Lat.	Long.	Date	Time (GCT)	Surface Sal. ($^0/_{00}$)	Surface Temp. (° F)	BT No.*	Oceanog. Sta. No.	Weather	Clouds Form	Clouds Tenths	Wind Dir.	Wind Force	Air Temp. (° F)** Dry	Air Temp. (° F)** Wet	Sea† State	† Vis.
52° 39′ N	177° 07′ W	21 Jul	0840	33.20	43.6	59	22	Fog	St	10	190	4	46.0	46.0	2	4
52° 28′ N	176° 58′ W	21 Jul	1100	33.21	44.5	60		Fog	St	10	180	5	46.0	45.5	4	3
52° 14′ N	175° 59′ W	23 Jul	2310	33.13	44.0	61		Fog	St	10	280	2	49.0	46.0	2	2
52° 26′ N	175° 34′ W	24 Jul	0240	33.125	44.6	62	23	Overcast	Sc, St	10	060	2	45.5	45.2	2	7
52° 38′ N	175° 14′ W	24 Jul	0457	33.17	44.7	63		Overcast	Sc	10	060	2	46.0	45.0	2	7
52° 52′ N	174° 55′ W	24 Jul	0659	33.11	46.0	64		Overcast	Sc	10	050	3	46.5	45.0	2	7
53° 11′ N	174° 25′ W	24 Jul	1112	33.17	45.8	65	24	Overcast	Sc	10	070	1	46.5	45.5		
53° 18′ N	174° 28′ W	24 Jul	1224	33.17	45.4	66		Overcast	Sc	10	090	2				
53° 18′ N	174° 27′ W	24 Jul	1335			67		Overcast	Sc	10	090	2				
53° 32′ N	174° 32′ W	24 Jul	1600	33.06	45.6	68		Overcast	Sc	10	050	2			2	8
53° 47′ N	174° 37′ W	24 Jul	1800	33.10	45.5	69		Overcast	Ns	10	050	4			3	7
54° 01′ N	174° 41′ W	24 Jul	2155	33.06	45.4	70	25	Light rain	Ns	10	100	4	44.8	42.5	2	7
54° 16′ N	174° 46′ W	25 Jul	0100	33.05	45.9	71		Light drizzle	Ns	10	080	5	44.7	44.4	3	7
54° 28′ N	174° 50′ W	25 Jul	0300	33.12	45.7	72		Overcast	St	10	060	4	44.5	44.5	3	6
54° 46′ N	174° 56′ W	25 Jul	0500	33.12	45.4	73		Overcast	Sc	10	060	4	45.5	44.5	3	7
54° 54′ N	174° 41′ W	25 Jul	0911	33.11	45.6	74	26	Overcast	Sc	10	060	4	45.8	45.0	3	7
54° 58′ N	174° 16′ W	25 Jul	1130	33.13	45.7	75		Overcast	Sc	10	030	5	45.7	45.0	3	7
55° 04′ N	173° 54′ W	25 Jul	1330	33.10	45.5	76		Overcast	Sc	10	050	4	45.4	45.0	3	7
55° 10′ N	173° 21′ W	25 Jul	1530	33.12	45.1	77		Light drizzle	St	10	050	4	45.0	44.7	3	5
55° 14′ N	173° 00′ W	25 Jul	1926	32.745	46.0	78	27	Overcast	St	10	050	4	45.5	45.0	3	8
55° 31′ N	172° 34′ W	25 Jul	2207	32.72	45.7	79		Overcast	St	10	040	4	46.0	45.5	3	7
55° 44′ N	172° 16′ W	26 Jul	0005	32.70	46.0	80		Overcast	St	10	030	3	45.9	44.7	3	8
55° 54′ N	172° 01′ W	26 Jul	0206	32.66	46.2	81		Overcast	St	10	030	3	46.4	45.4	3	8
56° 00′ N	171° 54′ W	26 Jul	0551	32.70	46.2	82	28	Overcast	St, Ac	10	030	2	45.5	45.0	3	8
56° 09′ N	171° 40′ W	26 Jul	0750	32.65	46.9	83		Overcast	St	10	030	3	45.7	45.0	3	8
56° 18′ N	171° 27′ W	26 Jul	0925	32.59	46.2	84		Overcast	St	10	030	3	45.5	44.5	3	8
56° 24′ N	171° 18′ W	26 Jul	1200	32.52	45.9	85	29	Light drizzle	St	10	310	3	44.5	44.0	3	6
56° 35′ N	171° 03′ W	26 Jul	1415	32.35	46.1	86		Light drizzle	St	10	330	3	44.5	44.2	3	6
56° 42′ N	170° 53′ W	26 Jul	1633	32.33	44.6	87	30	Overcast	St	10	350	3	45.0	44.7	3	8
56° 54′ N	170° 36′ W	26 Jul	1936	32.21	45.8	88		Overcast	St	10	310	4	44.5	44.0	3	8

* Cruise no. 606, assigned by SIO Bathythermograph Processing Section.

** Commencing at BT no. 13, air temperatures were taken with a motor-driven aspirating psychrometer. Probable accuracy of temperature differences between dry and wet bulb: $\pm 0.3°$ F.

† International Code.

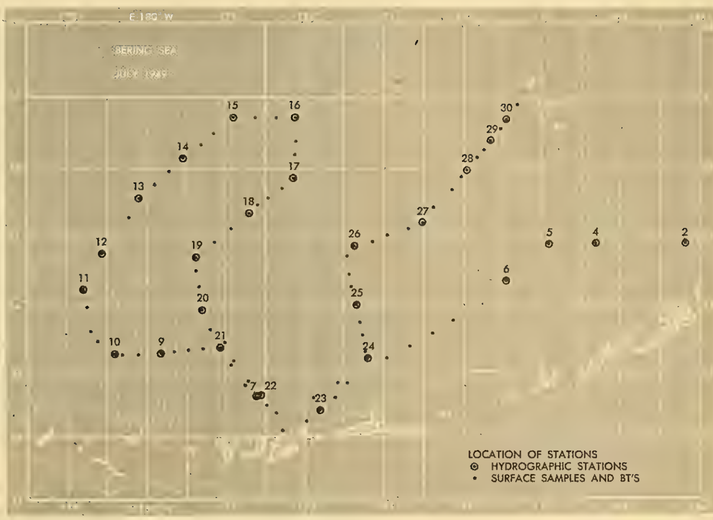


Figure A1. Location of observations, deep Bering Sea, summer 1949.

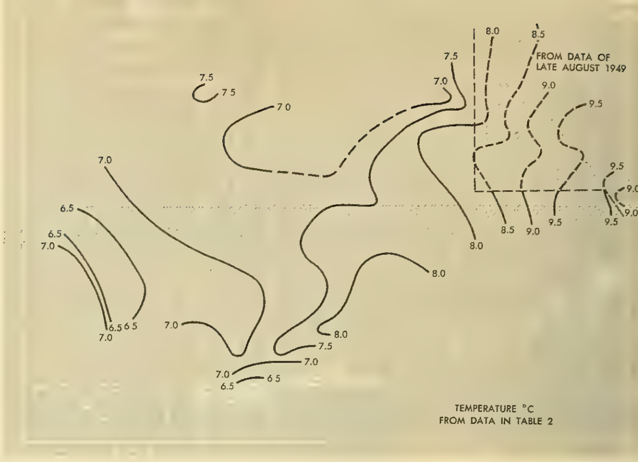


Figure A2a. Temperature, surface.

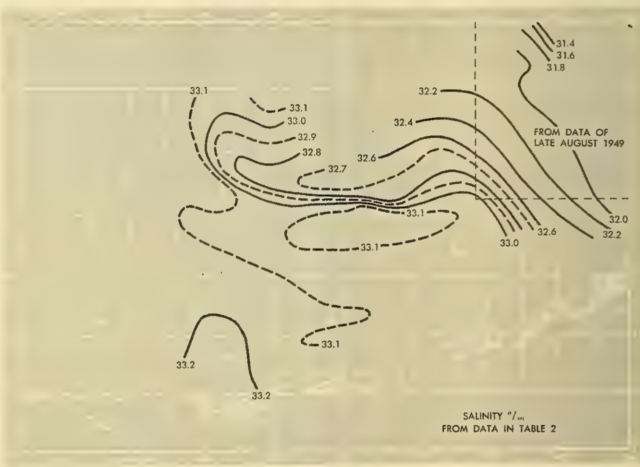


Figure A2b. Salinity, surface

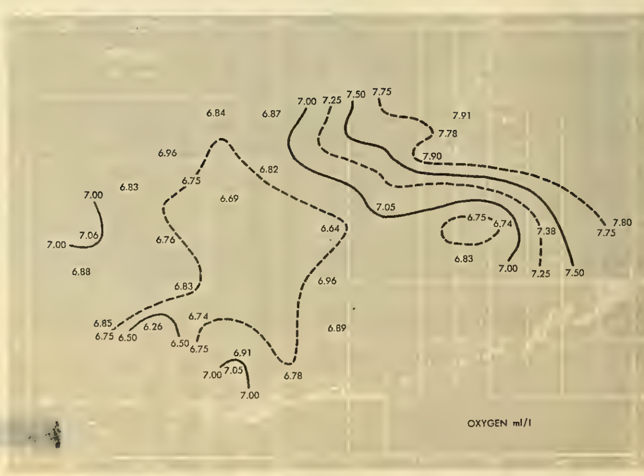


Figure A2c. Oxygen, surface.

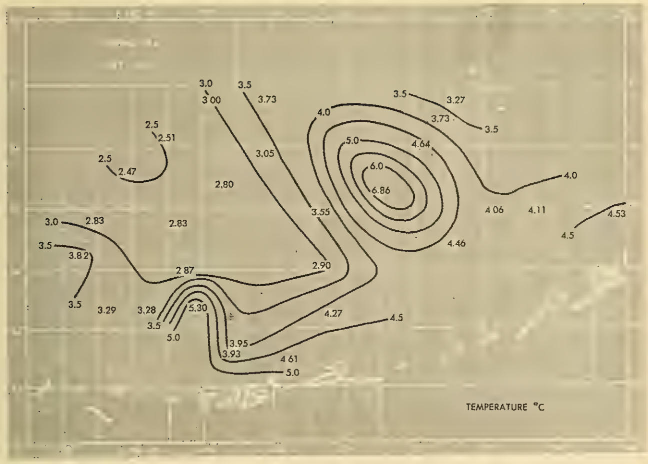


Figure A3a. Temperature, 50 meters.

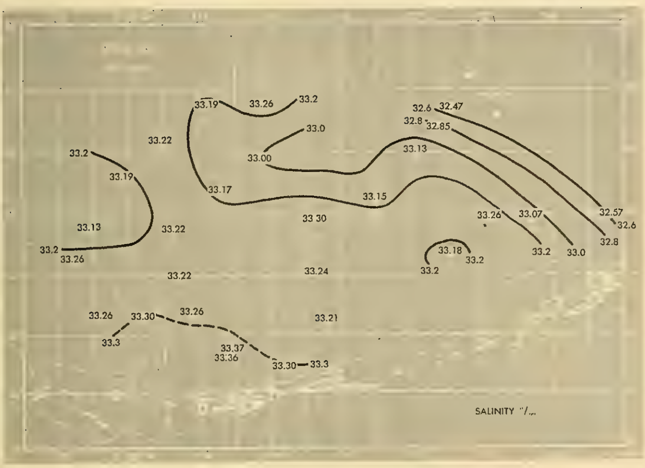


Figure A3b. Salinity, 50 meters.

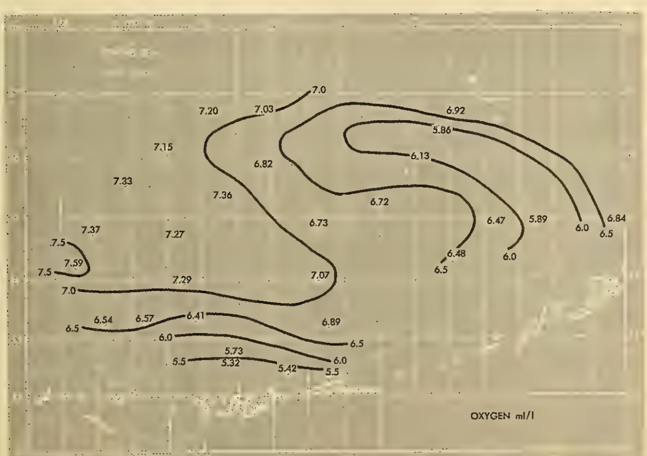


Figure A3c. Oxygen, 50 meters.

Figure A4a. Temperature, 100 meters.

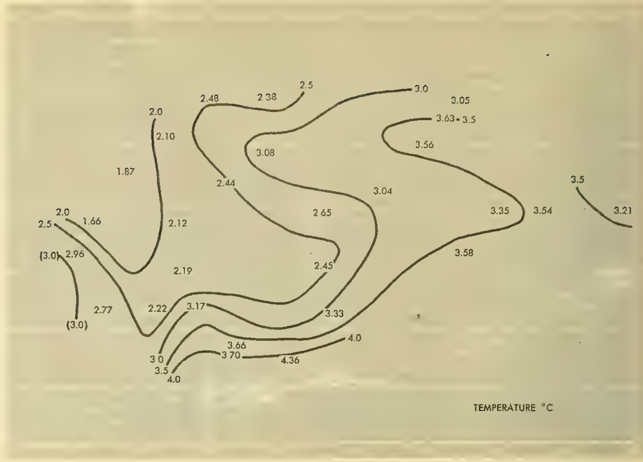


Figure A4b. Salinity, 100 meters.

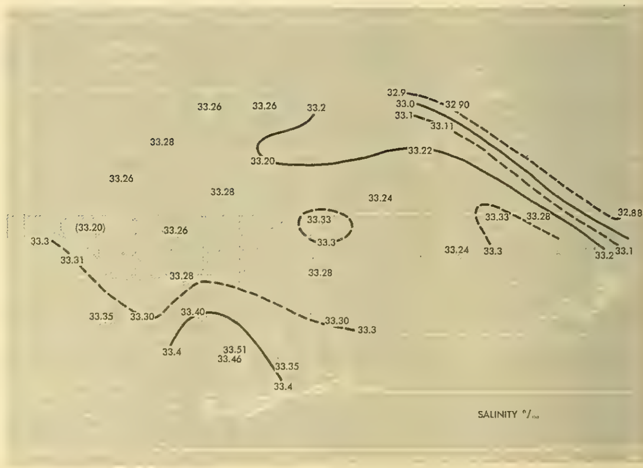
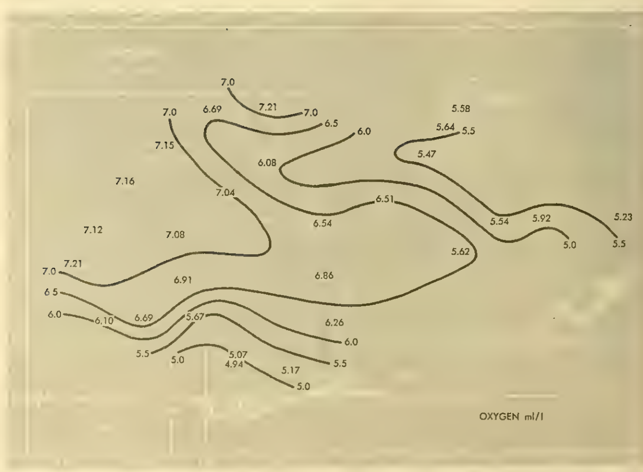


Figure A4c. Oxygen, 100 meters.



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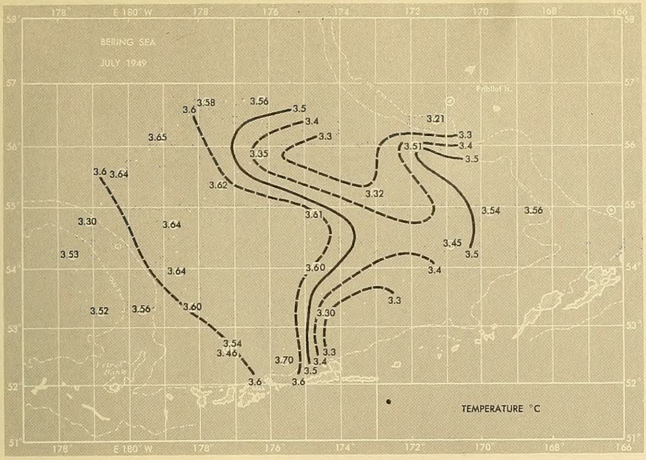

Figure A5a. Temperature, 250 meters.

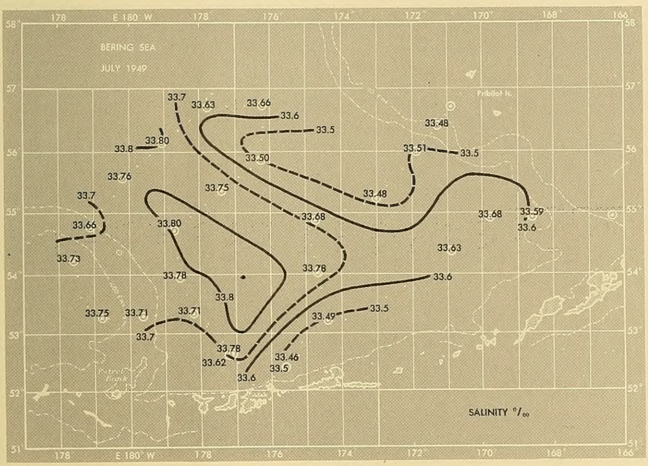

Figure A5b. Salinity, 250 meters.

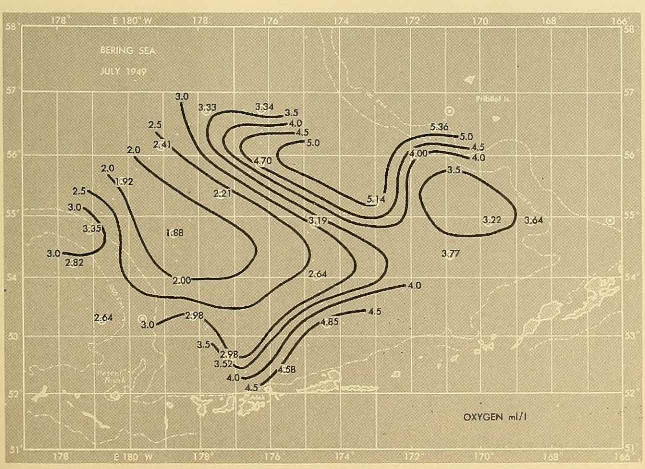

Figure A5c. Oxygen, 250 meters.

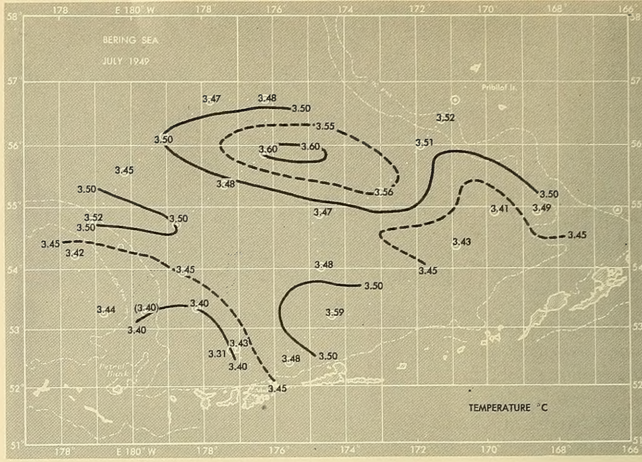

Figure A6a. Temperature, 500 meters.

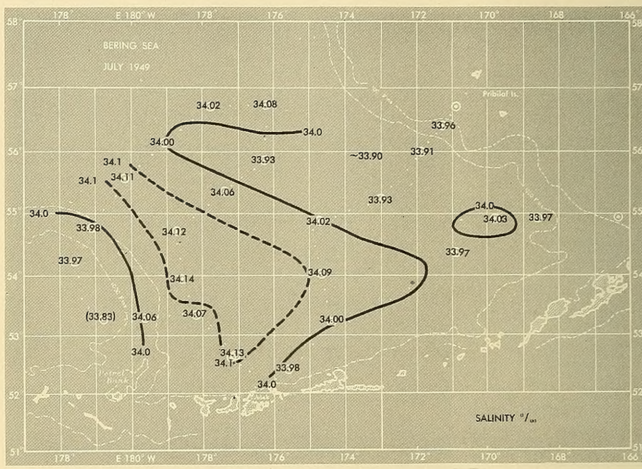

Figure A6b. Salinity, 500 meters.

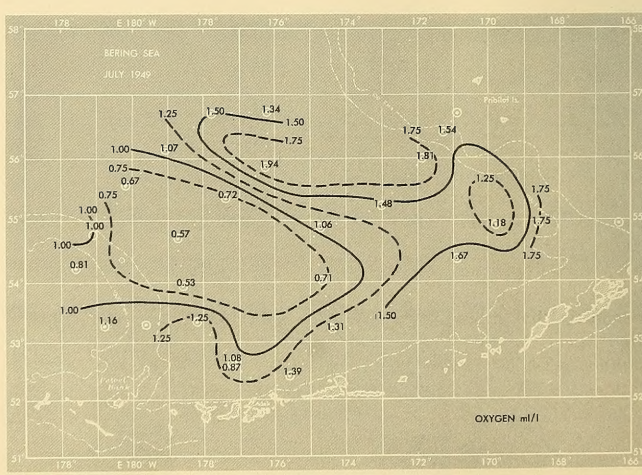

Figure A6c. Oxygen, 500 meters.

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Navy Electronics Laboratory. Report 298.
OCEANOGRAPHIC CRUISE TO THE BERING AND CHUKCHI SEAS, SUMMER 1949: Part III, by J. F. T. Saur, Jr., R. M. Lesser, A. J. Carsola, and W. M. Cameron. 40 pp. and figs., 6 June 1952.

The results of physical oceanographic observations made in the southeastern Bering Sea during the summer of 1949 were analyzed. The main conclusions were: (1) a sharp temperature minimum occurs at depths between 100 and 150 meters; (2) the computed surface circulation is counterclockwise; (3) there is some doubt as to whether the generally accepted northeasterly surface current from between Komandorski and Near Islands across the central Bering Sea to St. Matthew Island actually exists; (4) a well-developed deep sound channel exists in the deep Bering Sea during summer.

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1. Bering Sea — Oceanography
I. Saur, J. F. T., Jr.
II. Lesser, R. M.
III. Carsola, A. J.
IV. Cameron, W. M.

NE 120221
NEL Problem 2A5

[redacted]

Navy Electronics Laboratory. Report 298.
OCEANOGRAPHIC CRUISE TO THE BERING AND CHUKCHI SEAS, SUMMER 1949: Part III, by J. F. T. Saur, Jr., R. M. Lesser, A. J. Carsola, and W. M. Cameron. 40 pp. and figs., 6 June 1952.

The results of physical oceanographic observations made in the southeastern Bering Sea during the summer of 1949 were analyzed. The main conclusions were: (1) a sharp temperature minimum occurs at depths between 100 and 150 meters; (2) the computed surface circulation is counterclockwise; (3) there is some doubt as to whether the generally accepted northeasterly surface current from between Komandorski and Near Islands across the central Bering Sea to St. Matthew Island actually exists; (4) a well-developed deep sound channel exists in the deep Bering Sea during summer.

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